Toronto Tomorrow

A new approach for inclusive growth

SIDEWALK LABS

2

The Urban Innovations

Land Acknowledgement

Sidewalk Labs recognizes that this land we now call Toronto has been the site of human activity for over 15,000 years; we are within the Treaty Lands and claimed Territory of the Mississaugas of the Credit. Toronto is now home to many diverse First Nations, Inuit, and Métis peoples. It is the responsibility of all people to share in wise stewardship and peaceful care of the land and its resources. We are mindful of a history of broken treaties, and of the urgent need to work continuously towards reconciliation, and we are grateful for the opportunity to live and work on this land.

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Volume 2 Introduction

A New Set of Capabilities to Address Urban Challenges

Volume 2 describes the emerging physical, digital, and policy innovations that make it possible to improve quality of life in Toronto — and other global cities — at this unique moment in history.

Cities have always been humanity's greatest engines of opportunity, invention, and community, through their ability to connect so many diverse people in the same place.

They are where newcomers come for a fair shot or a fresh start. They are the wellsprings of arts, culture, and counterculture, where creativity sprouts along sidewalks and that next big idea is always around the corner. They are places that nourish both community networks and independent minds. They are global economic anchors and the planet's best hope for a greener future.

But cities have reached a pivotal moment in their development. The quality-of-life challenges facing Toronto are being experienced by rapidly growing metros around the globe, from New York to San Francisco to London and beyond.

Income inequality is growing, with more and more households unable to afford homes near their jobs.

Commuters spend hours a day trapped in traffic congestion.

Energy consumption must get leaner and cleaner to protect the environment.

Downtown neighbourhoods with limited developable space are squeezed for parks, open spaces, schools, health services, and community centres.

The proliferation of data and digital devices in cities has left people rightly concerned about their privacy.

While every city faces these problems in its own way, the symptoms are consistent: places that are less livable, affordable, and sustainable — with fewer chances for the broadest diversity of residents to thrive.

As these challenges rise, so too has the opportunity to address them using emerging digital and physical capabilities, such as ubiquitous connectivity, artificial intelligence, and sensing tools, as well as new design and fabrication techniques, including the use of robotics.

This suite of capabilities represents a fourth urban technological revolution of the modern era, potentially every bit as transformative for cities as the steam engine, electric grid, or automobile before it. But as the history of those prior revolutions shows, innovation can have great social benefits or significant drawbacks depending on how thoughtfully it is incorporated into urban life.

The steam engine gave rise to industry and brought new job opportunities, but it led to terrible smog and poor work conditions. Electricity brought cities 24/7 activity, elevators, and skyscrapers, but it furthered reliance on fossil fuels. The automobile made it easier to get people and goods in and out of cities, but it generated enormous congestion and led households to leave cities for the suburbs.

Applying new technology to cities in a thoughtful way is difficult. The urban technologies emerging today face an inflection point.

Self-driving vehicles have the potential to make city streets dramatically safer, but only if they always follow the rules of the road. Factory-based construction can meaningfully improve housing affordability and accelerate development, but these savings must support below-market housing programs and robust public policies to reach their full benefit. Digital connectivity can expand job opportunities and encourage innovation, but it must come with a process that protects privacy and the public good.

The lesson from history, as well as from the recent smart cities movement, is clear: technology is not a quick fix for complicated urban challenges. Instead, new advances must be incorporated into the city with great care to improve urban life, not undermine it.

But infusing new capabilities into the urban environment is hard. Cities are complex places. The technologists who produce ambitious solutions do not speak the same language as the urbanists who must find ways to implement them in the public interest — an "urbanist-technologist" divide. These two groups have very different tolerances for risk, different requirements for transparency, and different expectations for how long things take to get things done.

That is why no single city stands as a new model for a brighter urban future.

Developing innovations to improve urban life

Key Term
Urban Innovation
is the integration of physical, digital, and policy advances to improve urban life.

Sidewalk Labs was founded in 2015 for the very purpose of delivering dramatic improvements in urban life — on the belief that tackling these challenges is possible with a careful integration of emerging innovations and forward-thinking urban design. To fulfill that mandate, Sidewalk Labs assembled a unique team from across the worlds of urban planning, urban development, and digital technology.

Together, this team has developed a unique approach to "urban innovation," broadly defined as the integration of physical, digital, and policy advances into the urban fabric to improve quality of life in cities. Much more than just the pursuit of isolated efficiencies associated with "smart cities," urban innovation requires a thoughtful interdisciplinary approach that sits at the intersection of two of the defining trends of the 21st century: global urbanization and technological change.

Sidewalk Labs team members identify innovations that are beginning to be deployed to improve life in cities, drawing inspiration from the cutting-edge work being done by urban planners and designers around the world, as well as from the capabilities being developed by leading technologists, ranging from digital infrastructure and geospatial mapping to self-driving vehicles and energy management.

Critically, this approach does not presume that Sidewalk Labs alone would develop all the innovations a city might need. On the contrary, Sidewalk Labs aims to create the open conditions for ongoing improvement — recognizing that the best solutions to urban challenges come not from the top down but rather from the community up.

An innovation toolkit for the future city.
Volume 2 of the Master Innovation and Development Plan (MIDP) provides greater detail on the physical, digital, and policy innovations that make it possible to address some of the toughest challenges facing cities at this unique moment in time across core areas of urban life. These innovation plans focus on Toronto, but they also represent a general toolkit that could be applied in different ways to other growing cities around the world.

These core areas include:

Chapter 1:
Mobility.
A transportation system that reduces the need to own a car by providing safe, convenient, connected, and affordable options for every trip.

Chapter 2:
Public Realm.
A system of streets, parks, plazas, and open spaces that encourages people to spend more time outdoors, together.

Chapter 3:
Buildings and Housing.
Sustainable buildings that can be constructed and adapted far more quickly, and a new set of financial and design tools that help improve affordability and expand options for all households.

Chapter 4:
Sustainability.
A new standard of sustainability that creates a blueprint for truly climate-positive communities.

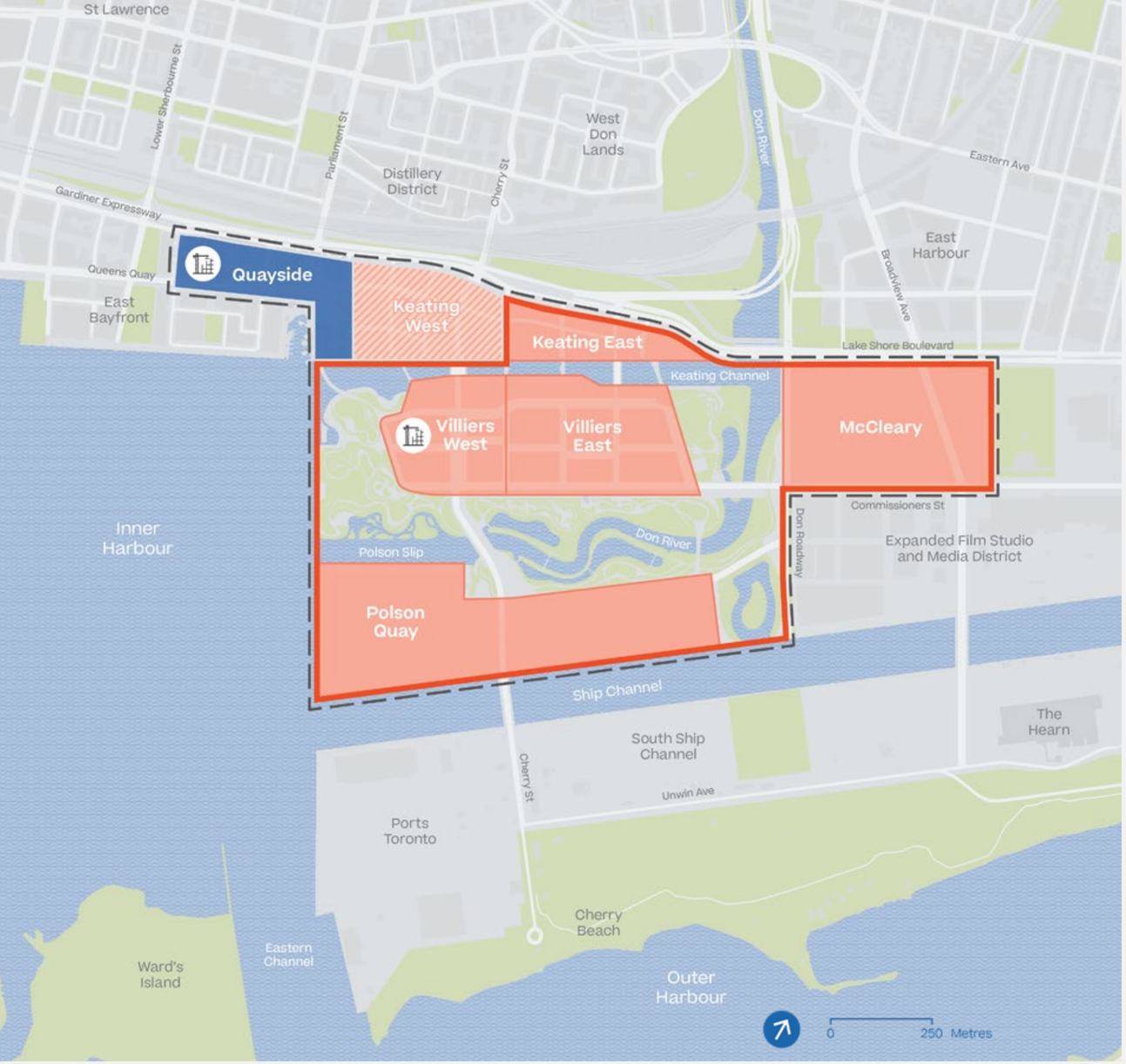
Chapter 5:
Digital Innovation.
Catalyze digital innovations that help tackle urban challenges and establish a new standard for the responsible collection and use of data in cities.

No community is complete with a cross-cutting layer of social infrastructure that could provide support to health, civic life, learning, and workforce initiatives that enable people to thrive. But given its intricate ties to a specific place, social infrastructure is explored in greater detail in the planning sections of the MIDP found in Volume 1.

Still, many general aspects of social infrastructure can be found across the Volume 2 chapters, including the health benefits of walking and cycling infrastructure (on Page 45 of the "Mobility" chapter), new housing types suited to families and seniors (on Page 236 of the "Buildings and Housing" chapter), and new digital tools that can empower community decisions (on Page 444 of the "Digital Innovation" chapter).

Applying urban innovations across the IDEA District.
Many of the urban innovations described in Volume 2 require a sufficient geographic scale to maximize quality-of-life impact — and to become financially viable in the first place.

To demonstrate the full potential of the innovations included in this volume, their impact has been measured across the entire proposed Innovative Design and Economic Acceleration (IDEA) District: a 77-hectare area that includes Quayside and the River District (as well as private parcels in this geography that would have the option to join the IDEA District, such as Keating West).



Map

The proposed IDEA District geography

The proposed 77-hectare IDEA District provides sufficient scale for urban innovations to realize ambitious quality-of-life outcomes in a financially sustainable way.

See Volume 3 for the proposed governance structure of the IDEA District, including the role of a public administrator in overseeing the district.

The IDEA District also addresses the fact that many of the innovations described in Volume 2 require regulatory or policy changes.

Many existing urban regulations and policies were designed in an earlier era, when the primary way to achieve necessary public policy outcomes involved sweeping, one-size-fits-all regulations. While designed around important objectives, these policies now sometimes limit the ability to find creative solutions to the very same problems they attempted to mitigate.

For example, single-use zoning regulations that separate residential and non-residential uses were intended to protect the public from industrial hazards. But an "outcome-based building code" system with real-time sensors that monitor for nuisances, such as noise, could enable neighbourhoods to incorporate light production uses into residential buildings, creating more vibrant streets and greater economic opportunities while still ensuring safety.

Core to the premise of the IDEA District is an empowered and forward-thinking public administrator that can prioritize innovation and new approaches without compromising the public interest.

With the right physical, digital, and policy conditions in place, and sufficient scale to realize their full quality-of-life benefits, the urban innovations described in Volume 2 can not only show a path forward for Toronto — they can also spark the imagination of cities tackling the challenges of diverse, equitable, and inclusive growth around the world.

Chapter 1

Mobility

Ch–1

Introduction

The Vision

A transportation **system that reduces the need to own a car** by **providing safe, convenient, connected, affordable options** for every trip.

On a typical weekday morning, the familiar challenges of getting around Toronto can be seen and felt across many downtown street corners.

Commuters huddle at transit stops, waiting for a bus snarled in traffic or a streetcar packed with riders. Drivers inch forward in frustration, many already an hour into their trip. Delivery trucks make their way towards a curb or dock to off-load a growing number of packages. Cyclists navigate through narrow lanes or alongside moving traffic, with the added obstacle of slush or snow in the winter. Pedestrians hurry across wide streets before the light turns.

The daily scene captures a fundamental urban tension: the more success that growing cities like Toronto experience, the harder it can be for transportation networks to fulfill their core mission of helping people get around easily, efficiently, and at a price that everyone can afford. The strain extends to local streets and sidewalks, which cannot reach their potential as safe, vibrant spaces for people.

The costs — social, physical, and environmental — are high. Across the Greater Toronto Area (GTA), traffic congestion costs more than $11 billion a year[1] in lost productivity, according to the C.D. Howe Institute. Sidewalk Labs estimates that, at the household level, Torontonians who live downtown and have a car spend, on average, over $10,000 a year in car-ownership,[2] a total that reflects monthly payments, parking, gas, insurance, and maintenance. That cost is often the second largest household expense after rent or a mortgage, but unlike owning a home, cars quickly depreciate in value over time.

For many families, there is little choice: on average, Toronto area residents who commute by public transit spend nearly 100 minutes travelling each day,[3] according to Statistics Canada. As a result, roughly 70 percent of households[4] in Toronto, and 84 percent of households across the GTA, own at least one car, according to the 2016 Transportation Tomorrow Survey. Even in downtown neighbourhoods served by public transit, roughly half of all households own a car.[5]

But the need for an effective transportation system is more than just an urban statistic. It can be the difference between making a business meeting or losing an opportunity, spending more time with family or sitting alone on the freeway, forking over money for car payments or using it for savings or vacations. It can be the difference between arriving at work feeling calm and prepared — when the trip has been fast, relaxing, and convenient — or already exhausted, having battled traffic, delays, and breakdowns.

The innovation plan.
Sidewalk Labs has a comprehensive vision to integrate street design and placemaking, innovative policy, and transportation technologies — new and old — to provide a broad menu of affordable choices for every trip, reducing the need to own a car and setting a bold new course for urban mobility.

The first step towards achieving this vision of balanced mobility is to focus on expanding traditional public transit. No other transportation mode can carry as many people, as efficiently and affordably, through a dense urban environment. Sidewalk Labs proposes innovative financing mechanisms that do not rely solely on public funding and can accelerate existing plans for light rail expansions.

The next step is to make neighbourhoods like Quayside even more pedestrian- and bike-friendly than comparable downtown areas, stitching the waterfront back into the city and connecting people to a range of jobs and essential daily needs through walking or cycling. Taken together, transit extensions and walking and cycling improvements should allow almost all residents of Quayside to meet their daily travel needs without a car.

The critical third step is to help households make the occasional car trip without owning a car. A new generation of ride-hail services makes it possible to serve these trips at a far lower cost than privately owned cars do today, without adding more vehicles to city streets, through pricing that encourages sharing. These services are poised to become even more convenient and affordable with the prospect of self-driving technology.

Self-driving vehicles could become both widely available and demonstrably safer than today's drivers over the next 15 years.[6] Their ability to operate as fleets or shared services could enable cities to recapture most of the street space once devoted to parking, and to repurpose this space for bike lanes, wider sidewalks, transit services, or pick-ups and drop-offs that would make it easier to live comfortably in the city without owning a car.

Cities all over the world will need to figure out how to adapt to self-driving vehicles, and may defer significant decisions until after the vehicles are widespread. At that point, many cities will look to whatever successes exist. Toronto's leadership in this area of urban policy could make the city a global model and a centre of expertise for generations to come.

Benefits of implementing the vision

- An affordable set of trip options without the high cost of car-ownership
- A self-financed public transit expansion that connects thousands of people to jobs
- Safer, more vibrant streets that help the city eliminate traffic fatalities
- A global model for integrating self-driving vehicles into street designs

Another set of benefits would come from freight and management innovations. To help keep trucks off local streets, Sidewalk Labs plans to create a logistics hub connected to neighbourhood buildings through underground delivery tunnels.

And to coordinate the entire mobility system, Sidewalk Labs proposes a new public entity that uses real-time traffic management tools, pricing policies, and an integrated mobility package to encourage transit, walking, cycling, and shared trips.

Finally, as a foundation for this entire system, Sidewalk Labs proposes a people-first street network specifically designed to keep traffic moving while enhancing safety, comfort, and street life for pedestrians and cyclists.

The impact.

Integrated at the scale of a development the size of Quayside, a neighbourhood of roughly five hectares with only a handful of intersections, Sidewalk Labs' mobility plan can lead to measurable but limited improvements to job access, household costs, safety, pollution levels, and public space for residents.

When these concepts are applied across a larger area, transformative change becomes possible. For instance, public transportation is key to making any new development accessible and affordable, but the costs of extending the waterfront transit line have proven prohibitive. Planning for a greater scale of development along the eastern waterfront enables a self-financed public transit expansion that can unlock the increased densities needed to accommodate population growth, setting an example for other parts of the city.

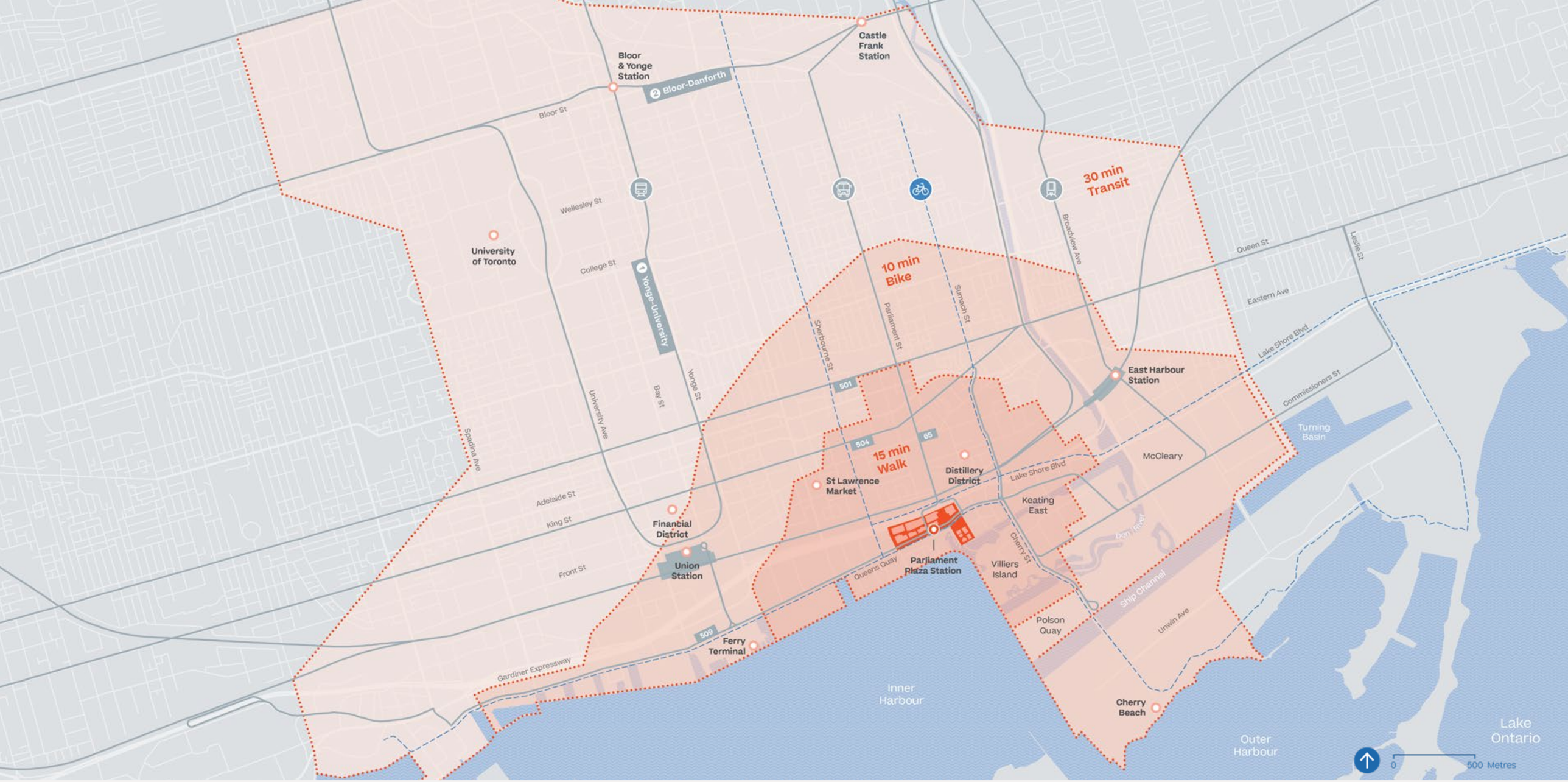
At this larger scale, a network of streets designed for the comfort, convenience, and safety of pedestrians and cyclists can not only help the city progress its Vision Zero objective of eliminating traffic fatalities and severe injuries, but provide new links between tens of thousands of housing options and jobs. A variety of options for shared mobility services can fill any remaining gaps, enabling visitors, workers, and residents to access much more of the city quickly and easily.

If this integrated vision were implemented across the full proposed IDEA District, Sidewalk Labs projects that just 10.7 percent of all trips would be made by private cars, far below the 27.2 percent made in comparable neighbourhoods, such as Liberty Village. The result would show the way forward for a truly balanced transportation system that helps the city grow and thrive.

This integrated vision would show the way forward for a truly balanced transportation system that helps the city grow and thrive.

IDEA District

The 77-hectare Innovative Design and Economic Acceleration (IDEA) District, consisting of Quayside and the River District, provides sufficient geographic scale for innovations to maximize quality-of-life impact and to become financially viable.



Map

Creating a balanced transportation network that connects to the city

City transit

Primary bike routes

Quayside

Travel times from Parliament Plaza Station
(a new light rail station located
near the centre of the neighbourhood)

This map shows the time it would take to travel from Quayside to other parts of the city by walking, cycling, and taking transit. The mobility plan presented in this chapter aims to ensure that residents, visitors, and workers have convenient, affordable access to the rest of the city.

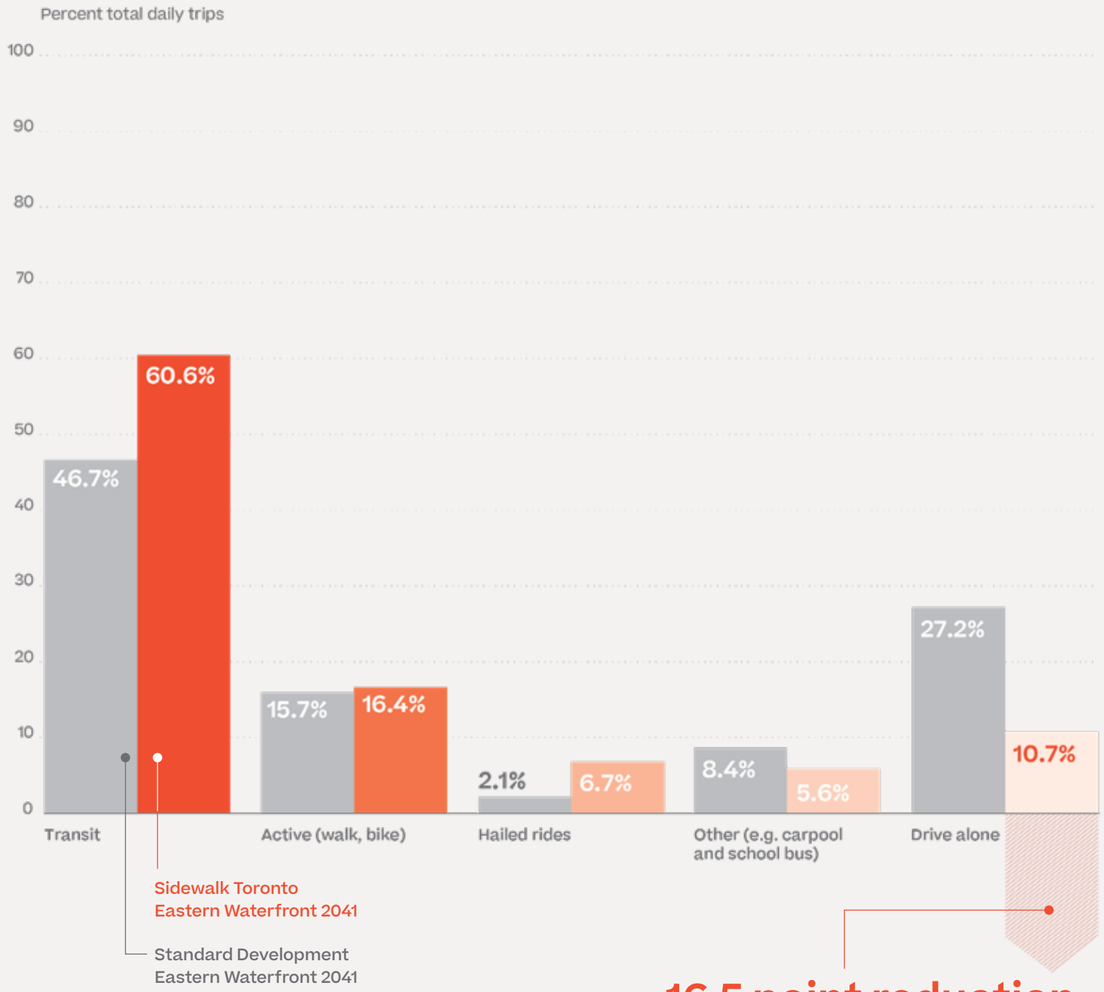
Source data:

Transit area data from Sidewalk Labs G4ST model
Walk and bike area data from Sidewalk Labs

How the mobility plan reduces private car trips

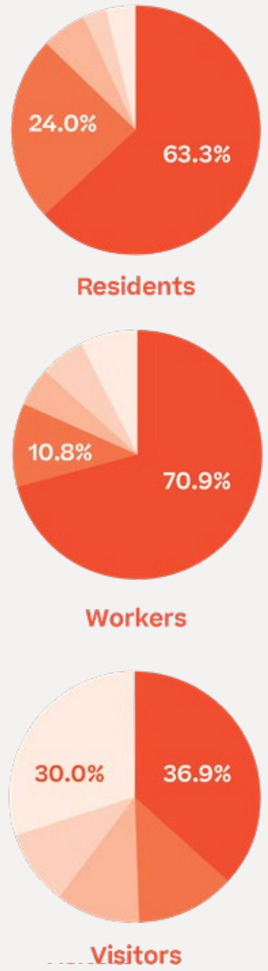
Taken together, the mobility improvements described in this chapter would reduce the percentage of trips made by private automobiles in Quayside (2025) to 13 percent, and to 10.7 percent in the full proposed IDEA District (2041).

The 2041 figure assumes a fully deployed mobility system, including self-driving fleets, traffic management, and the light rail extension. As a result, Sidewalk Labs would expect very few households in the IDEA District to feel the need to own a car.



% Total daily trips per type of traveller

Sidewalk Toronto Eastern Waterfront 2041



Residents and employees would have the highest use of transit and active transportation, while many visitors would likely arrive by private vehicle.

Sidewalk Labs analysis

A note on modelling

To help design its transportation network, Sidewalk Labs used a model called the Greater Toronto Area Model 4.0 for Sidewalk Toronto, or G4ST, in addition to more traditional analysis tools. This model builds on the official GTA Model 4.0 developed by the University of Toronto, which is used as the official model of the city to understand how new developments can impact the transportation system.

How it works.
G4ST uses a representative sample of travel behaviour to simulate the travel patterns of residents, workers, and visitors coming and going from Quayside, including trip modes (such as car, transit, cycling, and walking), routes, and origins and destinations.

What is new.
On top of these basics, G4ST incorporates some new elements specific to the Sidewalk Toronto project, such as the potential performance of transit service patterns, costs of self-driving fleets, and the effectiveness of parking and curbside pricing.

Its limitations.
All models are simplifications; for example, no one can predict the impact of new regulations on travel behaviour or the emergence of new technology with full accuracy. The G4ST model is an attempt to represent travel demand and decisions, but Sidewalk Labs recognizes that modelled mode shares and results are best seen as indicators of outcomes rather than perfect projections.

How it helps.
G4ST has helped inform planning decisions for some essential features of Quayside's mobility network, such as the number of curbside spaces, vehicle lanes, bike lanes, bike-share stations, and bike-parking spots, as well as the layout of roads.

What it shows.
Based on all these inputs, G4ST shows that private car usage would be 10.7 percent at the full scale of the IDEA District, down 17 percentage points from what would be expected from standard development, enabling the neighbourhood to devote more space to housing, public uses, cycling, and walking.

See the "Modelling and Transportation Analysis" section of the MIDP Technical Appendix for more details on G4ST.

Ch–1

Part 1

Expanding Public Transit

Key Goals

1
Design a neighbourhood with transit first

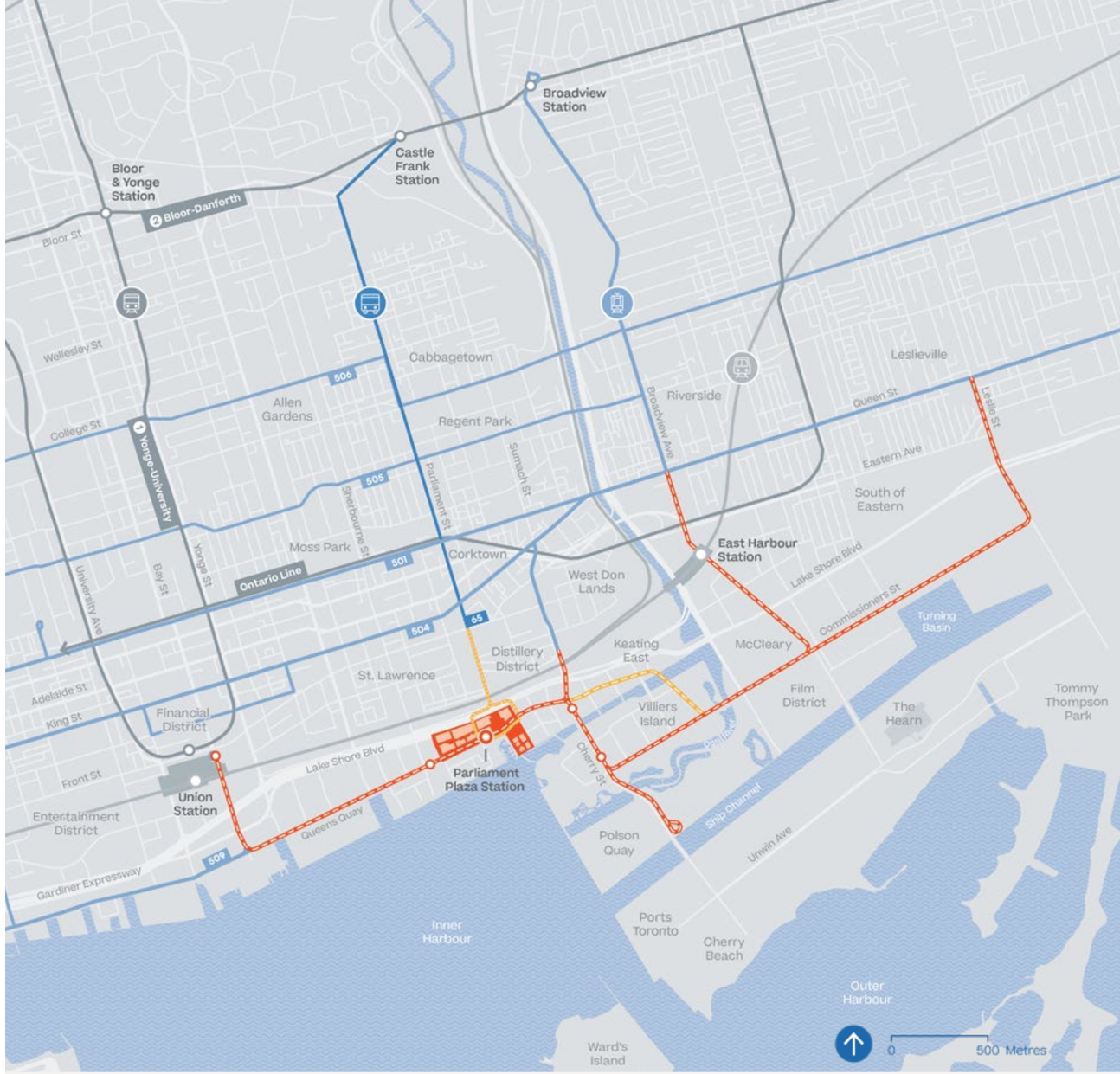
2
Encourage expansion through "self-financing"

The first step to mobility success for any new downtown neighbourhood is to connect into the existing transit system of the surrounding city — ideally before any residents move in.

It may seem odd for a 21st-century neighbourhood to embrace 19th-century technologies, such as urban rail transit. But public transportation is unmatched in its ability to carry the most people most efficiently, and at the most affordable price through cities. Those journeys, connecting tens of thousands of strangers every day and linking neighbourhoods across the region, help generate the economic activity and exchange of ideas that make cities great engines of personal prosperity and social advancement.

In Toronto, as in many major cities, the biggest challenge for public transit expansion is funding.[7] Reluctance to incur the debt necessary to offset the cost of new transit projects has bedevilled the GTA for many years. That aversion to spending on new transit poses a particular problem for the eastern waterfront, where a proposed 6.5-kilometre light rail expansion remains unfunded despite being discussed for more than a decade. Finding a way to build this system in advance of development is the key to sustainable growth; without it, the area will face increased traffic congestion and lock residents and workers into the need to own a car.

Sidewalk Labs' plan to address this challenge begins by advocating the construction of the 6.5 kilometres of light rail transit proposed in the Waterfront Transit Network Plan. A recent report commissioned by the Waterfront Business Improvement Association found that this addition alone would result in a 15 percent increase in public transit use by local workers and residents, and a corresponding 44 percent decrease in automobile use. It also found that accelerating the line's completion by 20 years would save 100 million hours of commuting time.[8] Beyond the approved plan, Sidewalk Labs further proposes an optional second phase of construction to add light rail infrastructure to the area north of the Keating Channel to serve future development.



Map

Extending the public transit network along the waterfront

- GO Transit / SmartTrack
- Subway (existing and planned)
- Light rail
  - Existing
  - Approved extension
  - Optional
- Bus
  - Existing
  - Proposed by Sidewalk Labs
- Quayside
- Parliament Plaza Station

See the “Innovation and Funding Partnership Proposal” chapter of Volume 3 for more details on transit financing.

Extending the LRT could generate

$22.8 billion

in additional tax revenue.

By 2041, the LRT extension could serve

72,900

riders daily.

The total cost of this investment to the public is approximately $1.2 billion[9] (see map on Page 38). Given the project’s fundamental importance, Sidewalk Labs is prepared to provide assistance with the financing for the approved plan. As per the Waterfront BIA report, construction of the Eastern Waterfront LRT could provide $22.8 billion in additional tax revenue to the governments of Toronto, Ontario, and Canada over the 20 years following completion of the project.[10]

Construction of this light rail extension would lead to excellent financial outcomes for the public. These outcomes can be made even better through public use of the innovative funding mechanism of self-financing, sometimes referred to as “value capture,” which would allow the light rail expansion to finance a portion of its own costs. The idea behind self-financing is to impose a future charge on real-estate development, and borrow in the present against that stream of funds to pay for part of the cost of construction of the transit system. Self-financing requires a large enough development area that real estate values can credibly reach sufficient levels to fund expensive transit projects, which means the government could only employ this tool if development expands east beyond Quayside along the waterfront.

The corresponding benefits would be immense: several new connected neighbourhoods, creating homes for thousands of people who would enjoy quick public transit connections to the rest of the city. The presence of high-quality light rail transit makes it possible to create an IDEA District where people of all incomes choose not to own a car. Sidewalk Labs estimates that by 2041 the light rail would serve roughly 72,900 Torontonians travelling to the IDEA District per day.[11]

An innovative self-financing mechanism could help build the long-desired LRT extension, unlocking the eastern waterfront’s potential.

Goal 1

Expanding Public Transit

Design a neighbourhood with transit first

For many years, Torontonians have recognized that the key to unlocking the potential of the eastern waterfront is through public transit access. The existing plans include a series of light rail lines through the area, as well as the proposed downtown relief subway and the construction of the planned East Harbour SmartTrack and Metrolinx commuter rail station. While funding has failed to materialize, there is general consensus on the overall shape of such a system, as articulated in the Port Lands Planning Framework and the Waterfront Transit Reset efforts.

Sidewalk Labs believes this system should operate as light rail service. This service would be interoperable with the wider streetcar network, using the same vehicles on the same rails with the same electrical infrastructure. But it would operate in its own right-of-way, with priority at intersections and stops spaced farther apart than the stop-on-each-corner spacing common elsewhere in the city. These changes elevate the system from streetcar service to light rail service, which is faster and more reliable.

This expansion is vital to the waterfront’s future. The existing plans (Segments 1 through 9) are even more important for the prospect of commercial development in the IDEA District than they are for Quayside. To build on these plans, Sidewalk Labs proposes an optional additional link (Segment 10) to extend the planned network and improve access to and from the IDEA District.

These expanded plans can be pursued at a total estimated cost of approximately $1.2 billion (roughly $1.3 billion if the optional Sidewalk Labs link were included). With this infrastructure in place, the full scale of the IDEA District could become home to tens of thousands of residents, jobs, and visitor destinations, while being fully integrated into the rest of the city — all without overloading local roads with traffic.

It is critical to ensure that these segments get built prior to the start of new development. There are many examples from around the world of what happens when a new development fails to link into the city's transit network. Three key lessons stand out:

1

New transit must connect into a system. Sometimes a new development overlooks the need for neighbourhood transit service to connect with a larger existing network. London's Canary Wharf development filed for bankruptcy in 1992, due partly to its highly publicized lack of transit access, which made it impractical for commuters. The project rebounded following improvements to the Docklands Light Railway[12] and, later, after a subway extension to the site. As this case shows, the failure to integrate into an established transit network can isolate a development and stunt its growth.

Toronto's Liberty Village area initially lacked sufficient public transit access, leading to heavy traffic congestion, overcrowded streetcars, and widespread commuter frustration. Credit: David Pike

2

Ignoring transit worsens congestion. Another oversight is the tendency to build a high-density development without any transit at all. Many fast-growing Asian cities have made this mistake, leading to the traffic gridlock and air pollution that characterize places like Mumbai[13] and Jakarta.[14] Liberty Village,[15] in Toronto, followed a similar path. In such cases, the initial result is absolute gridlock, because cars simply cannot carry the volume of people that a high-density place needs. Governments are then forced to retrofit a public transit system into the neighbourhood, which can often result in significant financial costs and travel disruptions.

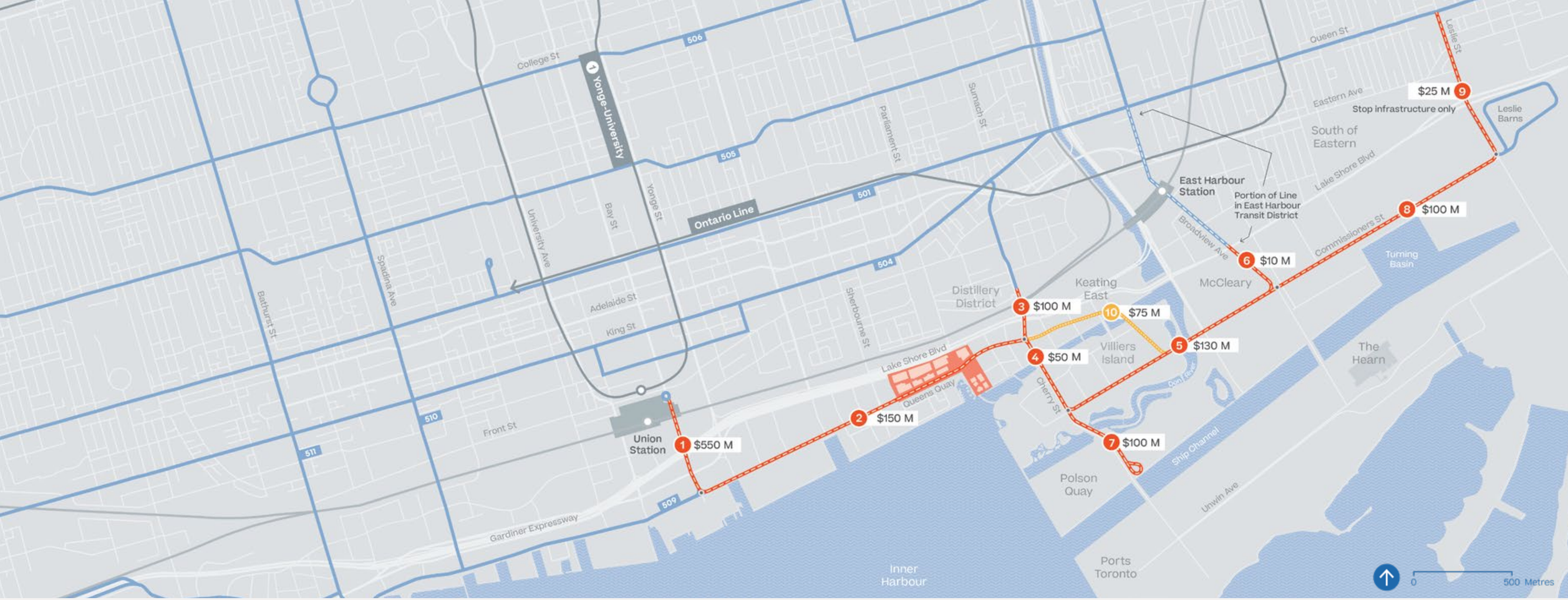
3

Delaying transit expansion locks in car use. New developments will sometimes build extensive road and parking capacity to accommodate cars in the near term, while hoping that public transit will eventually arrive. This approach locks the area into a car-first orientation that is difficult to change even over decades. The mobility patterns established when a neighbourhood is first built are very difficult to change, and history has shown time and again that widening roads to relieve congestion is a temporary solution that requires enormous public funding and ultimately worsens the problem.

This mobility vision integrates street design, innovative policy, and transportation technologies to set a bold new course for urban mobility.

Map

A $1.2 billion plan to extend light rail along the waterfront



GO Transit / SmartTrack
Subway (existing and planned)
Light rail
- Existing
- Approved extension
- Optional

Quayside

Toronto's current plan would provide a critical connection between Union Station and Queens Quay 1 and extend the waterfront light rail east beyond Bay Street to reach Quayside and the greater eastern waterfront at Cherry Street 2.

The plan would create a connection to the King Street transit corridor via Cherry Street, near the Distillery District 3.

New service would run along Cherry 4, Commissioners 5, and the Broadview extension 6 creating an essential connection between Quayside, Villiers, and the East Harbour SmartTrack Station, with the potential to connect to Broadview Station.

The plan would extend service along Cherry 7 to a turnaround on Polson Quay, replacing the current turnaround by the Distillery District.

Finally, to help connect the eastern part of the Port Lands to the greater system, the plan calls for extending the Commissioners line east 8 to Leslie Street, linking the new network to the Leslie Car Barns and to the broader streetcar network via Leslie 9.

Additionally, as part of the work to rebuild the Cherry underpass to accommodate the light rail, Sidewalk Labs proposes also rebuilding the Parliament underpass, to create a pleasant gateway into Quayside.

As part of a second phase of construction, Sidewalk Labs proposes an optional new connection, not part of the existing approved plan, to extend transit north of Villiers Island along the new extension of Queens Quay east of Cherry 10.

Goal 2

Expanding
Public Transit

Encourage expansion through "self-financing"

Traditionally, transit projects like the waterfront light rail expansion have been funded equally by the federal, provincial, and municipal governments, but no level of government has currently committed to funding new rapid transit in the eastern waterfront. A large-scale development of the area could make a substantial contribution to funding the transit system this area needs via a self-financing approach — and in so doing, set an example for how to finance the essential transit extensions necessary for sustainable urban growth.

Self-financing, through a value-capture approach like the use of special assessments or tax-increment financing, has been used in transit projects around the world, such as London's Crossrail[16] and Calgary's Rivers District Community Revitalization Plan.[17] There is precedent for self-financing in Toronto as well: the City of Toronto has approved its use to pay for a portion of the forthcoming SmartTrack project.[18]

The LRT extension would increase land value by

$4.5 billion

between 2025 and 2045.

The key issue with any self-financing plan is whether the transit expansion will create enough value to meaningfully offset the cost of building that expansion. The strategy is often not viable where new transit will serve existing neighbourhoods, because those areas are already sufficiently valuable, meaning that new transit services do not add much. Likewise, the new construction required in a low-density development plan may be unable to generate sufficient incremental tax or other revenues to make a meaningful contribution to high transit costs. A small neighbourhood consisting of just a few blocks, like Quayside, cannot generate enough revenue to repay the investment.

The LRT extension would increase transit trips by

60%

in the IDEA District.

But if the scale of the development is large enough, and that development can feature new construction at a high enough density, then a critical opportunity exists to design and fund a rapid transit system that can nourish a new neighbourhood and support its growth. Such an opportunity exists along the waterfront, where — as per the economic-impact report prepared by the Waterfront BIA for the city's approved plan — construction of the light rail would generate land value uplift of $4.5 billion between 2025 and 2045.[19] The feasibility of such a plan requires a commitment for enough new development at high enough densities to design and fund a rapid transit system that can nourish new neighbourhoods and support their growth.

In this event, public and public-private partners would need to finance some or all of the construction of the expanded light rail network, with an expectation that these partners would be paid back by future incremental tax revenues at a rate that is negotiated with the city. Construction of this network could be phased to keep pace with development. The light rail system would remain publicly owned and operated by the Toronto Transit Commission. A non-profit or new government entity could be created to oversee the implementation of this self-financing proposal; its role would be to manage the funds raised, which would be required by law to be used exclusively for the light rail expansion.

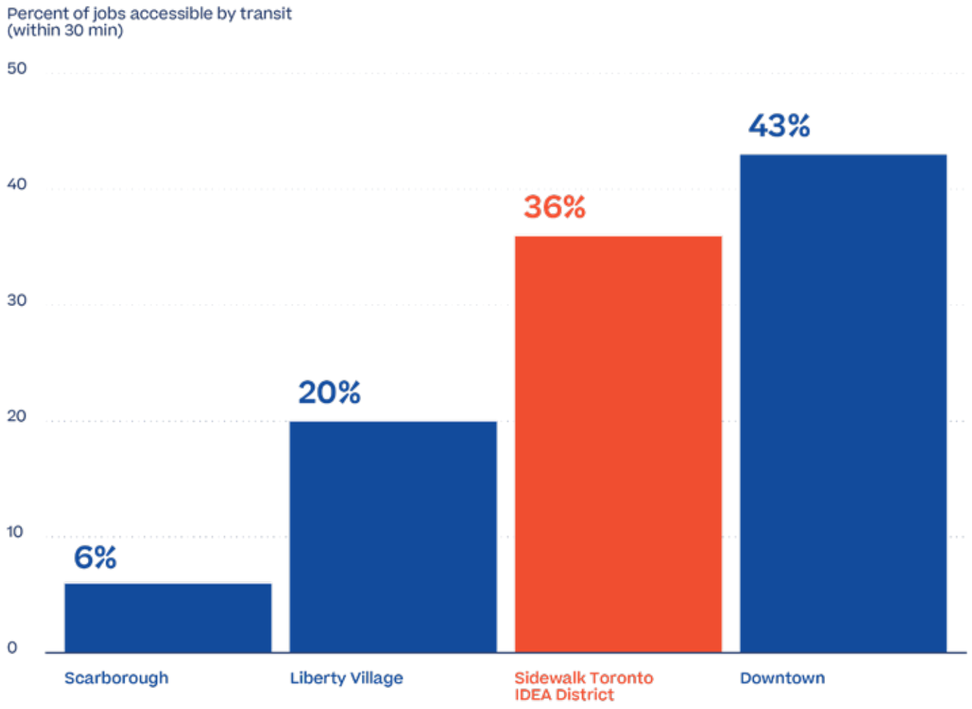
The light rail could serve more than 72,900 riders and make 36 percent of jobs accessible across Toronto within 30 minutes.[20]

Implemented across the full scale of the IDEA District, the extension — in conjunction with the other mobility improvements discussed in this chapter — could increase the number of trips taken by transit to 60.6 percent,[21] up from 46.7 percent with standard development.

Above all, extending the light rail via self-financing, beginning in Quayside, would demonstrate a new, financially sustainable way to create critical transit infrastructure with reduced taxpayer funding. Pioneering this approach could give Toronto-area governments a powerful tool to deliver the new transit infrastructure the city and region urgently require.

A neighbourhood comparison of job access via public transit

The light rail extension would make 36 percent of Toronto's jobs accessible to residents of the IDEA District within 30 minutes, making it more transit-friendly than other comparable neighbourhoods and approaching the type of transit access that can be found downtown.



Ch–1

Part 2

Enabling Walking and Cycling Year-Round

Key Goals

1
Plan for a "15-minute neighbourhood"

2
Expand safe, comfortable walking and cycling networks

3
Provide signal priority for walking and cycling

4
Encourage bike-share, e-bike, and other low-speed vehicle options

5
Facilitate all-weather walking and cycling with heated pavement

Establishing a strong transit system connected to the wider region is the first step towards ensuring that a neighbourhood provides affordable, accessible alternatives to owning a car. The next step is creating a walking and cycling network that enables people to travel easily and comfortably within their neighbourhood and to adjacent neighbourhoods.

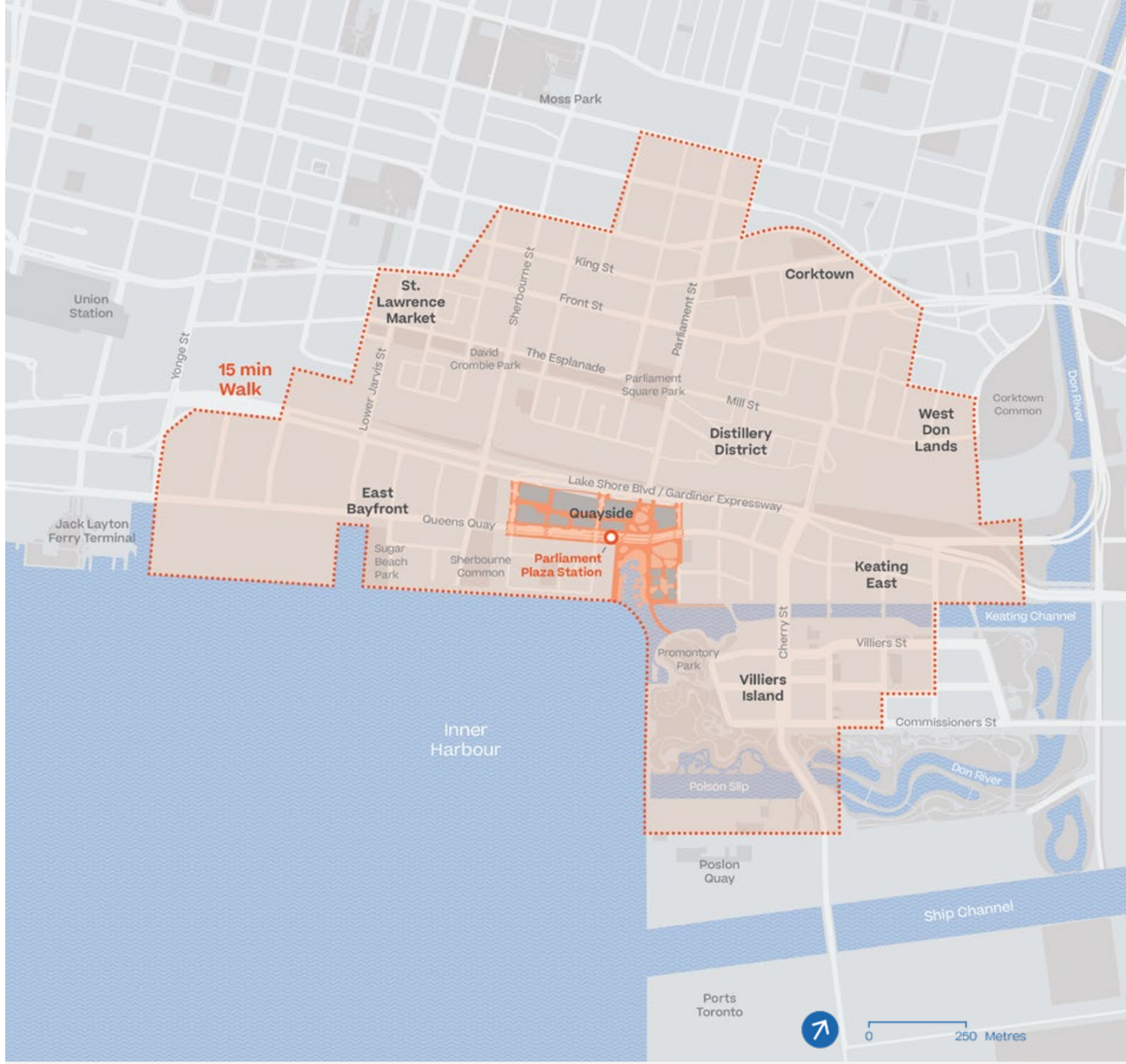
In recent years, Toronto has worked to improve its walking and cycling infrastructure. For example, the redesigned Queens Quay West demonstrates strong demand for protected bike lanes, as it hosts as many as 6,000 cyclists per day.[22]

But pedestrians and cyclists along the waterfront face steep challenges in the form of connectivity, safety, and comfort. The elevated Gardiner Expressway and the railway tracks present a barrier to walking or cycling between the waterfront and downtown, especially after dark. A general absence of bike lanes forces cyclists next to vehicle traffic, discouraging many would-be riders. Subfreezing temperatures, piles of snow, icy streets, and winds off the lake make cycling even more harrowing in winter.

Sidewalk Labs' plan for a comprehensive pedestrian-cyclist network integrates policy, design, and technological advancements that can make it dramatically easier to walk or bike within and around the IDEA District, and can serve as a model for walking and cycling in all types of downtown developments.

This approach would enable residents in the IDEA District to access all of their essential daily needs within a 15-minute walk; expand the walking and cycling network with people-first street designs and stronger links to adjacent neighbourhoods; give cyclists and pedestrians priority at intersections via adaptive traffic signals; encourage bike-share, e-bike share, and other low-speed vehicle options; and install heated pavement for year-round comfort and safety.

At the full scale of the IDEA District, Sidewalk Labs estimates that more than 16 percent of all trips to, from, and within this area would occur by foot, bike, or other low-speed vehicles — enabling households to meet daily needs without owning a car.[23]



Map

Neighbourhoods accessible to Quayside within a 15-minute walk

15-minute walk from Parliament Plaza Station

Quayside pedestrian access

Goal 1

Enabling Walking and Cycling Year-Round

Plan for a "15-minute neighbourhood"

Any strong, active transportation strategy starts with designing a walkable neighbourhood to enliven the streets, fill shops with customers, and create unexpected encounters. People walk even more if they can reach all their daily needs within about 15 minutes, or 1 kilometre.

Building on this insight means planning neighbourhoods where, within a 15-minute walk, an individual can find every service or good they are likely to need more than once a week. These include essential services such as schools, child care, and health care; necessities such as pharmacies and groceries; recreational destinations like restaurants, shops, and parks; and above all, plenty of jobs.

See the "Buildings and Housing" chapter of Volume 2, on Page 202, for more details on adaptable buildings.

Sidewalk Labs proposes to address this challenge by planning for a far more robust mix of homes, shops, production spaces, and jobs than found in a comparable neighbourhoods, such as Liberty Village. While this approach to planning is holistic in nature, some of the key steps include:

See the "Public Realm" chapter of Volume 2, on Page 118, for more details on stoa.

A mixed development program.
In contrast to conventional downtown developments in Toronto, which devote roughly 90 percent of space to residential use, Quayside's development program calls for 67 percent of space to be devoted to housing, with roughly 33 percent devoted to office, retail, community, and maker spaces, as well as other non-residential uses. Achieving that balance would create far more jobs and recreational destinations in Quayside than typical of Toronto neighbourhoods, enabling more residents to walk to work or to the store. To support this mixed program, Sidewalk Labs plans to deploy an adaptable building structure called "Loft," designed with flexible interior configurations to accommodate a range of residential, commercial, and even light industrial uses.

All-weather ground floors.
On the lower floors, these adaptable structures can house a variety of short-term, long-term, and seasonal tenants, allowing for a livelier mix of shops, services, community gathering spaces, and other destinations all within walking distance. Some of this "stoa" space would be designed with retractable awnings to invite foot traffic in all weather.

Last-mile transit connections.
Sidewalk Labs has paid special attention to ensuring high-quality pedestrian and bicycle connections to light rail and bus stops. As planned, cyclists would access these stations through either dedicated lanes or entire streets prioritized for bicycle travel, with ample bike parking and bike- and scooter-share access adjacent to stations. Pedestrians could access stations along pleasant sidewalks, and access platforms via wide crosswalks that prioritize safe crossing.

Access to social infrastructure.
To improve walkable access to essential services, Sidewalk Labs plans to provide space in Quayside for an elementary school co-located with a child care facility, health services co-located with supportive care programs, and community space for neighbourhood groups. The care and community spaces would also be included in the first phases of development to improve access from Day One.

In Quayside, the whole neighbourhood would be walkable within 15 minutes. When applied at the full scale of the IDEA District, Sidewalk Labs' plan to encourage a vibrant mixture of homes, jobs, shops, and public spaces on every block would lead to 9 percent of all trips being made by walking.[24]

Impact spotlight

The health benefits of active neighbourhoods

Research shows that life is healthier in walkable areas.

The Canadian Physical Activity Guidelines recommends that all adults engage in at least 30 minutes of moderate-to-vigorous physical activity every day.[25] If their neighbourhood is designed for it, they can get that exercise in the course of their normal daily routines, by walking or cycling. And the research shows that people who live in more walkable neighbourhoods get more exercise, and are healthier for it:

Increased fitness.
People who routinely walk and cycle experience improvements in heart rate, lung capacity, and metabolic health. A study by Statistics Canada found that residents of urban neighbourhoods were more likely to be physically active and to engage in active transportation than residents of inner or outer suburbs.[26]

Decreased obesity.
A 2015 study by Statistics Canada looked at the prevalence of obesity among urban and suburban Ontario residents. The conclusion: "Residents of highly walkable areas engaged in more utilitarian walking and had a lower prevalence of obesity than did adults in low-walkability areas." These basic findings — that active transportation correlates with lower obesity rates — are also borne out on a national and international scale.[27]

Lower blood pressure and heart rate.
A recent study in France found that living in a highly walkable neighbourhood is associated with improved cardiovascular health, including lower blood pressure and a lower resting heart rate.[28]

Lower disease risk.
A 2014 study cross-referenced a variety of health indicators against the street designs of 24 different California cities. The findings showed that more compact and connected street networks, with fewer lanes on their major roads, are correlated with reduced rates of diabetes and heart disease[29] (as well as lower blood pressure and reduced obesity rates) among residents.

Goal 2

Enabling Walking and Cycling Year-Round

Expand safe, comfortable walking and cycling networks

Among the main deterrents to walking and biking are the safety concerns and general discomforts that come with travelling beside big cars and trucks. While this concern may be true for any city, it is an increasing one in Toronto, where the number of street fatalities has been trending upwards over the past decade,[30] according to the Toronto Police Service. The vast majority of pedestrians and cyclists who reach their destination safely require vigilance to cross busy streets and to bike on unprotected lanes, which makes for an unpleasant experience, and is a steep barrier to walking or riding, especially with children.

Sidewalk Labs' redesigned street types ensure safe, convenient, and complete paths for people travelling by foot, bike, or other low-speed vehicles. This proposed network of streets would include Laneways, where traffic moves at pedestrian speeds, and Accessways, where traffic moves at cycling speeds. On Boulevards and Transitways, where traffic moves at vehicular speeds, the overall sense of safety and comfort for pedestrians and cyclists would be improved through the use of wider sidewalks and dedicated bike spaces. (See Page 92 of this chapter for more details on street types.)

In Quayside, this plan would only affect two streets; therefore, its impact would be limited. But applied across a larger area that covers most or all of a rider's route, this street network could transform the experience of cycling through a city. Within the IDEA District, cyclists would be able to reach 100 percent of buildings on a dedicated bike lane or roadway designed for bikes, compared to roughly 15 percent in a typical downtown Toronto neighbourhood today.[31]

A strong walking and cycling network does not end at the neighbourhood's limits. While the waterfront has easy walking and cycling proximity to the vibrant neighbourhoods of the Distillery District, Corktown Commons, and St. Lawrence, access to them is cut off by the need to cross under both the Gardiner Expressway and the railway lines leading to Union Station. Pedestrians and cyclists are subjected to loud noises, dark and narrow tunnels, confusing paths, and, occasionally, unknown liquid dripping from above.

To improve these connections, Sidewalk Labs proposes that the Parliament and Cherry underpasses be rebuilt. (The Cherry Street underpass must be rebuilt to accommodate the extension of the light rail line from the Distillery District in any case.) The rebuilt underpasses would separate pedestrians, bikes, cars, and public transit (consistent with the city's existing and planned bike and transit networks) to improve safety, add noise buffers and attractive lighting to enhance comfort and wayfinding, and install temporary display windows and digital art exhibits to make the walk fun and engaging.

Bike lanes or priority streets could connect to

100%

of IDEA District buildings.

Map

How the proposed bike plan expands opportunities for cyclists

- Existing network
- Primary separated lanes
- Proposed

City of Toronto bike routes

- Primary access
- Secondary access
- Improved underpass connection

Sidewalk Labs proposed bike routes

- IDEA District
- Quayside

This conceptual sketch of the reconstructed Cherry Street underpass shows decorative lighting, acoustic panels, bike lanes, and tree-lined walkways, which would create an appealing gateway between Toronto's downtown core and its emerging eastern waterfront.

Connections to the city's existing bike network are also critical. The Martin Goodman Trail, which runs through the waterfront, provides a natural cycling link to the rest of the city, and the underpass reconfigurations would provide an additional cycling link for Parliament and Cherry streets. The proposed connection to the existing on-street bicycle lane at Lower Sherbourne would allow riders to transition from a street where today bikes are given only a portion of the street to the bicycle-priority streets designed by Sidewalk Labs. In particular, Sidewalk Labs plans to connect to the existing and planned bicycle routes that would provide last-mile service to the future East Harbour station.

Finally, this emphasis on connections applies to developments along waterways, such as Keating Channel. In such a setting, Sidewalk Labs' approach aims to stitch together both sides of the waterway through a multitude of easily accessible, narrow bridges designed exclusively for pedestrians and cyclists, rather than funneling all types of traffic across one or two large bridges. This tapestry of connections reinforces the broader push for a walkable, "15 minute neighbourhood" and makes the waterway feel like part of the community, instead of a barrier.

Goal 3

Enabling Walking and Cycling Year-Round

Provide signal priority for walking and cycling

This bike lane in Copenhagen uses a "green wave": a signal coordination system, shown here through green pavement lights, that helps cyclists safely maintain higher speeds for longer distances. Credit: SWARCO

All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the "Digital Innovation" chapter of Volume 2, on Page 374.

For trips that take pedestrians and cyclists onto faster-moving streets, Sidewalk Labs plans to help ensure safety and priority for these travellers using new traffic signal technology. These signals have the ability to detect when pedestrians need more time at a crossing and can adjust signals accordingly.

For example, consider an elderly woman with a cane who starts crossing a boulevard, which is designed to handle the most vehicle traffic. A typical crossing signal changes the light when the predetermined crossing time is up, whether or not this person has made it across safely. But an adaptive traffic signal can detect that the woman remains in the middle of the street — in an anonymous way that preserves privacy — and extend the crossing time until she is safely on the other side. (See Page 91 of this chapter for more details.)

Sidewalk Labs plans to provide cyclists with similar priority by deploying "green waves," a concept pioneered in Copenhagen that uses signal coordination to help cyclists avoid hitting red lights so long as they maintain a certain speed.[32] (Sidewalk Labs plans to indicate green waves via LED strips on pavement.) These waves not only improve travel time but also increase safety, both because green waves make cyclists more visible to drivers, and because the timing between the waves allows safe crossing opportunities for pedestrians.

Goal 4

Enabling Walking and Cycling Year-Round

Encourage bike-share, e-bike, and other low-speed vehicle options

Some of the barriers to cycling — especially commuting by bicycle — are less about street design and more about access to bike options both at the start of a trip and when parking at a destination. The global trend of bike-sharing, including Toronto Bike Share, has made clear the value of using technology to make vehicles available on demand for one-way trips.

To encourage bike (and other low-speed vehicle) services in Quayside, Sidewalk Labs plans to create parking for nearly 3,800 bikes for residents and employees (20 percent more than required by regulation), 190 bike-share docks, 60 electric bikes, and 190 e-scooters. A neighbourhood of this size would typically have no more than 15 bike-share bikes (as per Toronto Bike Share criteria) and no dedicated space for e-bikes or scooters.[33]

Electric bikes and e-scooters help riders make their trips without the full exertion of traditional pedaling, expanding the distance someone might consider cycling. Both options are still emerging in North American cities, and e-scooters are currently not allowed in Toronto. Given Toronto's mobility objectives, Sidewalk Labs expects that e-scooter use will be adopted by the time Quayside opens; if not, Sidewalk Labs would seek to work with the city to use the neighbourhood to test how e-scooters could be used safely in Toronto.

Dockless vehicle shares — a new type of bike-share service that does not require fixed stations — are a recent addition to city streets. To provide this option while also preventing the disorder of bikes parked haphazardly across the public realm, Sidewalk Labs plans to designate parking areas for dockless vehicles.

To accommodate trips made on personal bikes, Sidewalk Labs proposes to require all buildings to create a minimum of one bike space per every two building residents and one bike space for every four employees. Given that studies show that arriving to work sweaty deters many would-be bike commuters, Sidewalk Labs plans to help provide on-site showers through agreements with fitness centres or a dedicated bike centre.

Quayside's low-speed vehicle infrastructure would include:

- 3,800 bike parking spaces
- 190 bike-share docks
- 60 electric bikes
- 190 e-scooters

Sidewalk Labs small research grant

How bike counting tools help cities plan bike infrastructure

Credit: David Edgar

How much road space should new neighbourhoods reserve for bike lanes? What is the best way to balance the needs of cyclists, pedestrians, cars, and other low-speed vehicles? What is the ideal number of bike-share stations, and where should they be located?

Planners can estimate these needs, but bicycle-counting technology can provide the detailed data necessary to ensure the optimal use of road space for all users, and even to encourage cycling. A recent report from the Samuelson-Glushko Canadian Internet Policy and Public Interest Clinic (funded by a Sidewalk Labs' small research grant) laid out the benefits — and the privacy risks — of collecting bicycle data.[34]

A wide variety of technologies are available to count bikes, including inductive loops embedded in roadways, that measure the change in the magnetic field when metal passes over them. Some bicycle counters work with video footage, others with infrared light, still others with laser-pulsing LIDAR. And old-fashioned manual counts can help by tallying things like bicycle helmets.

These technologies are often used in tandem, and the information they collect can be stored, analyzed, and retrieved through civic open-data portals. But sequential photo or video counting can reveal individual routes and other sensitive information.

To address this challenge, the report points to counter-measures that de-identify data collection. One such process, known as "k-anonymity," reserves the release of bike information until every combination of variables can be matched with at least "k" individuals, allowing cities to set an appropriate threshold. Some technologies, such as sensors that count cyclists via changes in light intensity, preserve anonymity from the outset.

The City of Ottawa has a comprehensive system for bicycle counting that includes algorithm-enabled cameras, and anonymized-at-source technologies such as inductive loops, infrared, and manual counts. Any identifiable data is anonymized before it is made accessible through the city's open data portal: planners can see the number of users on a particular bike lane, but not individual routes.

Goal 5

Enabling Walking and Cycling Year-Round

Facilitate all-weather walking and cycling with heated pavement

The climate presents a challenge to year-round walking and cycling in cold-weather cities like Toronto.

Many people report being "nine-month cyclists"; a Ryerson study found that only 27 percent of regular cyclists[35] continue to bike to work or school throughout the winter months. Meanwhile, icy or snowy streets can prove big obstacles to walking outside in winter. According to a City of Toronto report from 2016, roughly 3,000 Torontonians go to the emergency room every year after falling on ice or snow, and more than half of city residents over 65 report trouble moving around outdoors in winter, citing slippery sidewalks as their greatest concern.[36]

Sidewalk Labs plans to deploy heated pavement in some sidewalks and bike lanes to make walking and cycling more attractive all year. This pavement relies on modularity for easier access to the heating system, reducing maintenance costs and disruption, and takes advantage of new, efficient heating technologies that require less extensive piping systems to operate.

Sidewalks located near buildings would use hydronic heating, which circulates warm fluid just underneath the pavement surface, and can be powered by clean energy sources used by the neighbourhood's thermal energy grid. Pavers located towards the centre of the streetscape would rely on conductive heating, which involves embedding a thin film in or under the pavement, making it easier to maintain than heating that runs through thick pipes. Conductive heating can also run off clean electricity.

To conserve energy, heated pavement would connect to real-time weather forecasts programmed to automatically "power on" three or four hours in advance of a storm. The pavement would reach a maximum temperature of 2 to 4 degrees Celsius, which is capable of melting snow while remaining comfortable to walk on. The system would turn off automatically whenever the pavement is dry and no risk of black ice is present.

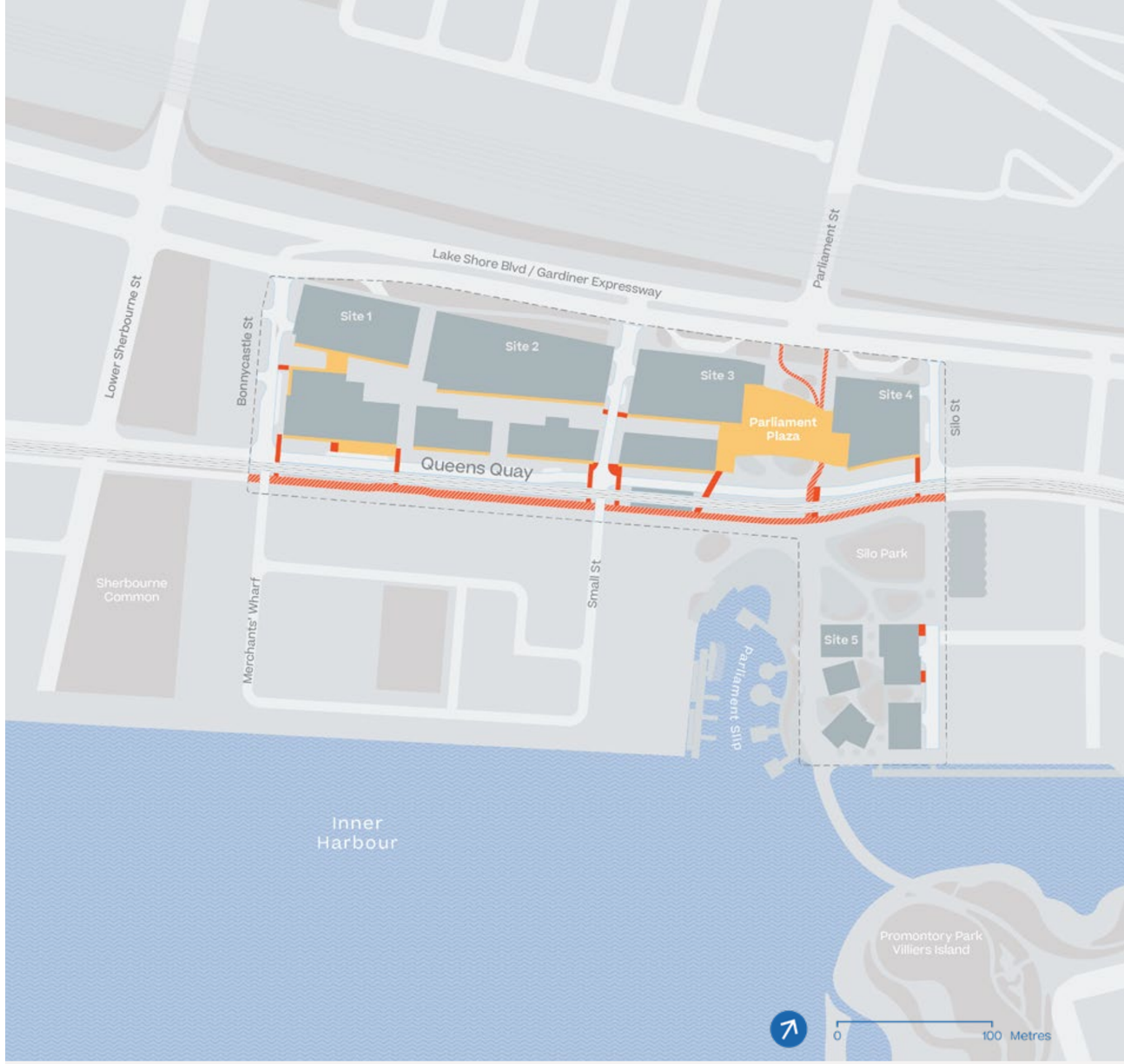
In Quayside, Sidewalk Labs plans to deploy 1,200 square metres of heated sidewalk and pedestrian zones and 1,590 square metres of heated bike paths.[37] The amount of power used to run the heating system would be closely monitored to ensure it supports the community's sustainability goals. All costs would be tracked to ensure that they meet modelled cost expectations for capital investment, ongoing maintenance, and associated costs.

Wind, rain, and even sun in warmer months can be significant barriers to walking along the waterfront. Sidewalk Labs plans to deploy an outdoor comfort system along sidewalks to shield pedestrians from wind and provide additional cover from rain and snow.

See the "Sustainability" chapter of Volume 2, on Page 296, for more details on the thermal grid.

Only 27%
of regular cyclists commute by bike in winter.

See the "Public Realm" chapter of Volume 2, on Page 118, for more details on outdoor comfort systems.



Map

Making it safer to walk and cycle year-round with weather mitigation

- Heated bike routes
- Heated pedestrian crossing
- Awnings, raincoats, and canopies
- Plowed streets
- Quayside site

The weather mitigation strategies proposed by Sidewalk Labs include heated pavers that could melt snow and ice on sidewalks and bike lanes, and building Raincoats that could protect adjacent outdoor areas from sun, rain, and snow.

Ch–1

Part 3

Harnessing New Mobility and Self-Driving Technology

Key Goals

1
Encourage shared use of ride-hail services

2
Provide car-share and parking options for the occasional private car trip

3
Make all trip options available in discounted mobility packages

In any major city, there are lots of trips that walking, cycling, and public transit cannot accommodate in a convenient way. The airport trip with lots of luggage. A hospital trip with an elderly parent. The weekend getaway to cottage country. The big shopping trip to the outlet mall. The trip home after a night out, so late that the subway is closed. The trip home of a hospital worker whose shift ends at 3 a.m.

Faced with these occasional needs, nearly half of the households in downtown Toronto choose to own a car. Yet, of these households, roughly half leave their car at home on weekdays, because they walk, bike, or take public transit to work,[38] meaning they pay roughly $900 a month to own, park, maintain, and insure a car simply for occasional trips. Some save money by parking on the street, but this imposes a cost on their neighbours, as street-parking spots take up space that otherwise could go towards public spaces or bike lanes, and real estate developers are required to create parking spots — a steep cost often passed on to tenants.

Breakthroughs in technology are generating a host of new mobility options that give households the freedom to make an occasional car trip without needing to own a car. These include ride-hail (taxi-like) services, such as Lyft or Uber; "microtransit" (van or shuttle) services; and car-share services that are bookable on demand, such as Zipcar.

These same services will get substantially cheaper and more convenient once self-driving technology becomes widespread. Indeed, no transportation technology holds as much potential to transform car-ownership as the self-driving vehicle.

The potential benefits are substantial. Crash fatalities caused by speeding, drowsiness, and drunk or distracted driving — which accounted for 66 percent of all vehicle fatalities on U.S. roads in 2016,[39] according to the U.S. National Highway Traffic Safety Administration — could largely disappear. Car commuters will be able to use their time more productively, and groups who currently cannot drive, such as people with visual impairments, may achieve greater mobility. Self-driving vehicles can be programmed to obey all traffic rules and defer to pedestrians. Early commercial operations of self-driving vehicles will likely occur through fleets, giving cities a tool to recapture significant amounts of public space devoted to parking.

Despite these upsides, the impact that self-driving vehicles will have on cities is unclear, and some observers warn about potential drawbacks that cities may need to guard against. These include increases in driving and vehicles on the road, if people overuse the ability to use self-driving cars to conduct errands without them.

Much of this outcome depends not on the technology itself, but on policy for how it is used. If self-driving vehicles are individually owned and free to roam the streets without a driver, then car-ownership — and congestion — might soar. But if self-driving vehicles are integrated into the urban environment and public transit network with thoughtful policies that encourage fleets of shared trips and people-first street designs, they can become part of a next-generation mobility system.

New mobility initiatives could save a two-person household
$4,000
annually.

Sidewalk Labs' new mobility plan integrates policy, design, and technology to harness the potential for fleets of self-driving vehicles and shuttles to provide the convenience of a car trip without the need to own one. This plan includes encouraging the shared use of ride-hail services through designated passenger zones and pricing, providing car-share and parking options for the occasional car trip, and making all trip options available in an integrated mobility package.

One of the Sidewalk Toronto project's most significant opportunities for innovation is to be the first to demonstrate how existing new mobility options — and the application of self-driving technology to these services — can meaningfully reshape cities for the better. Sidewalk Labs does not plan to operate new mobility services or self-driving vehicle fleets within the IDEA District, nor would it give any special prioritization to Alphabet sibling companies, such as Waymo. Instead, this new mobility plan is meant to lay the groundwork for an open ecosystem of third-party mobility services to operate in ways that benefit urban life, now and in the future.

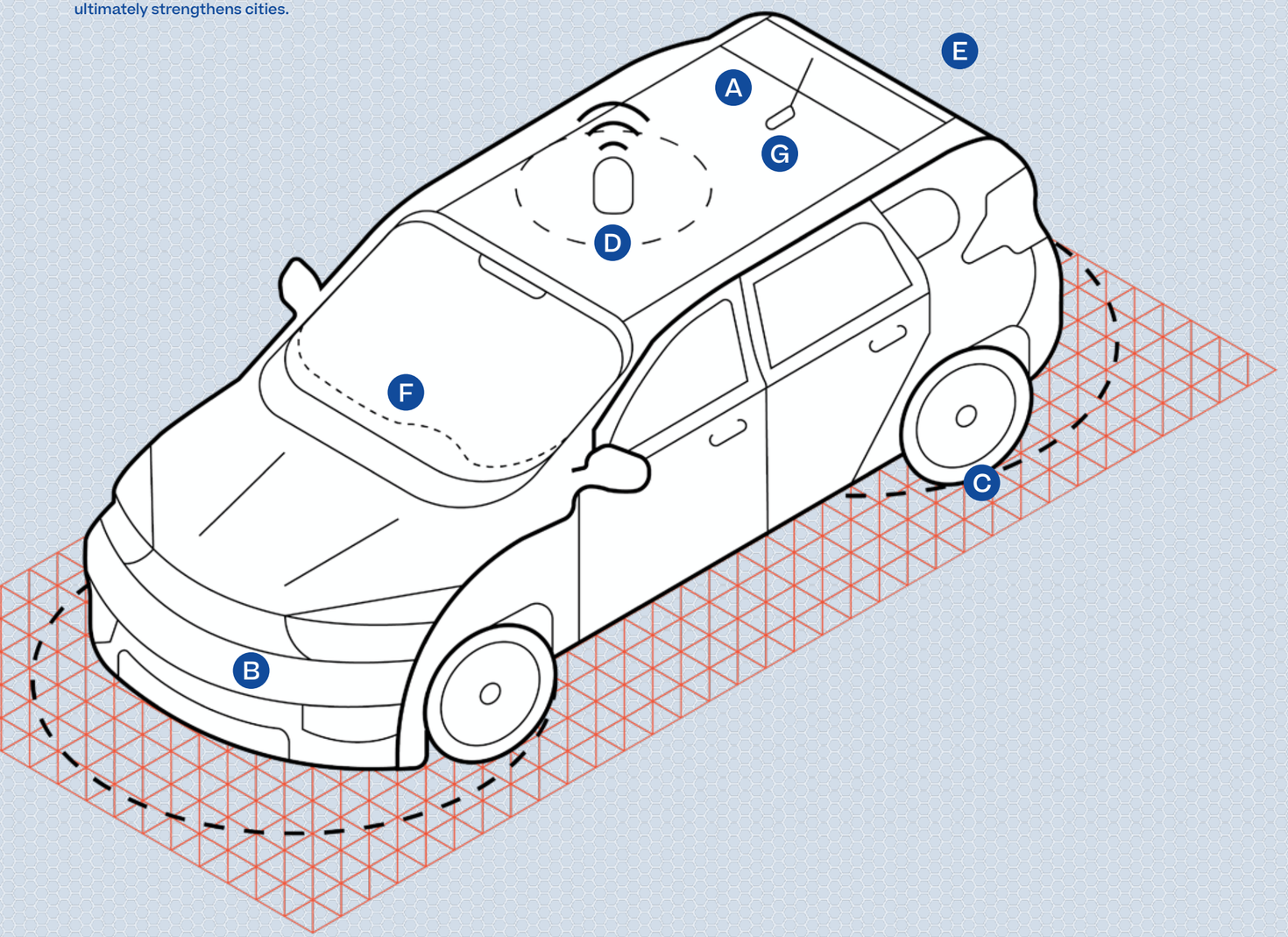
To that end, Sidewalk Labs supports research and stakeholder engagement initiatives that aim to improve the collective understanding of the effects of self-driving vehicles on urban transportation systems and to catalyze the consensus-building process to explore potential regulatory models. Sidewalk Labs was the funding partner of the MaRS Mapping the Autonomous Vehicle Landscape research initiative, which engaged government officials, industry leaders, and civic organizations, and mobility experts to identify regulatory priorities and dissect various governance models for the GTA.

With the arrival of self-driving technology, Sidewalk Labs' new mobility plan would lead to roughly 7 percent of all trips occurring by ride-hail options if applied at the full scale of the IDEA District and coordinated with the city, further helping households reduce the need to own a car. New mobility options such as self-driving ride-hail — combined with improved transit, cycling, and pedestrian options — form the basis of an integrated mobility package that could save two-person households roughly $4,000 a year if they choose to go car-free.[40]

In Focus

Self-driving vehicles have the potential to reshape cities

Sidewalk Labs believes that self-driving vehicles will become ubiquitous features of urban life within the next two decades. The next few pages explore how the technology works, summarize its evolution over the past half-century, and outline a series of principles to help ensure that self-driving technology ultimately strengthens cities.



Explainer: How self-driving vehicles drive

A breakdown of the technology behind this promising mobility advance

Roughly two-thirds of all crash fatalities are caused by speeding, falling asleep at the wheel, and drunk or distracted driving — hence the push to build cars that drive themselves. Self-driving vehicles never speed, fall asleep, drink alcohol, or get preoccupied with anything other than safely shuttling passengers to their destinations. Here is a look at how the technology[41] works:

A Planning a trip
Self-driving vehicles plan their route by accessing maps, traffic data, road and weather conditions, toll information, and more. They continuously refresh all that data throughout the trip, in real time, via an internet connection.

B Eyes on the ground
Front- and rear-mounted radar units determine the exact distances between the vehicle and other moving objects. Additional cameras and LIDAR sensors can also be mounted low on the vehicle.

C A game of inches
Existing vehicle GPS systems are typically accurate within one or two metres; a self-driving car requires greater precision than that. Its position estimators, mounted on wheels, can count tire revolutions and sense lateral movements. This data is layered atop detailed digital maps that include road grades, speed bumps, and curb-cut locations to determine the car's exact position.

D Eyes all around
A mini dome mounted on the car houses a LIDAR unit to help the vehicle "see." Using laser beams rather than radar waves, LIDAR generates dynamic, three-dimensional imagery for as far as 60 metres in every direction. The mini-dome also contains video cameras that recognize traffic lights, signage, pedestrians, and cyclists.

E Back-seat driver
In the trunk of the vehicle lies the brains of the operation: the computer that processes all this data through algorithms and converts it into driving decisions (when to stop, back up, accelerate, slow down, change lanes, and more). It is a very powerful computer, akin to a mobile, multi-server data centre.

F Computer vision
A system called "computer vision" processes the combined data from the LIDAR, radar, and camera systems to identify street users; classify them as pedestrians, vehicles, or cyclists; anticipate their movements; incorporate road rules; and make driving decisions.

G Lessons learned and shared
All this data is cumulative, just like years of driving experience. As the car encounters and navigates new or unusual situations, it learns from them for the next time — and shares this learning with every car in its fleet.

Self-driving vehicle technology: A brief history

1957

First driverless car on a public road
RCA Labs successfully tests an autonomous vehicle on a 120-metre stretch of highway near Lincoln, Nebraska. The car's steering was controlled via electronic detector circuits embedded in the roadway.[42]

1968

A proposal for computer control
In a visionary essay, Stanford professor and AI pioneer John McCarthy envisions "automatic chauffeurs" consisting of onboard computers and television cameras. "A fivefold reduction in fatalities is probably required to make the system acceptable," he wrote. "Much better is possible since humans really are rather bad drivers."[43]

1986

The robot car is born
Munich-based engineer Ernst Dickmanns creates VaMoRs, a Mercedes Benz van with two cameras, eight 16-bit Intel microprocessors, and a dynamic vision program that can recognize features and abnormalities on the road. VaMoRs navigates 20 kilometres of autobahn at speeds of 90 kilometres per hour.[44]

1995

No hands across America
Carnegie Mellon University researchers build the Navlab 5 self-driving car, which successfully navigates a 5,000-kilometre highway journey from Pittsburgh to San Diego. Navlab 5's guidance system,[45] nicknamed Ralph, steered the car while its passengers controlled acceleration and braking.

2004 to 2007

The original DARPA challenges
In 2004, the U.S. Defense Advanced Research Projects Agency (DARPA) offers a $1 million USD prize for autonomous vehicles that can navigate a 240-kilometre course in the Mojave Desert. None of the entries are successful, but a year later, with obstacles disclosed in advance, five vehicles succeed. In 2007, DARPA issues an urban challenge: complete a 95-kilometre city course in less than six hours. Four entries succeed.[46]

2009

Google's autonomous vehicle project
Under the banner of Google X, the company's then-research arm, Google begins developing and testing self-driving technology. In 2016 the project became the company Waymo.[47]

2012

Google's testing moves to the city
Having tested its driverless technology for more than 480,000 kilometres of highway, Google moves to city streets. While city streets have lower speed limits, their abundance of pedestrians, cyclists, signals and signage[48] makes them a greater challenge for computer-based vision and decision-making.

2016

Autonomous taxis hit the road
NuTonomy, an MIT spin-off that builds self-driving software systems, begins trials of its driverless technology[49] as a taxi service in Singapore. The following year, NuTonomy partners with Lyft[50] to provide driverless taxi service in Boston (though the service is later discontinued).

around 2035

Self-driving taxis become ubiquitous in Toronto
Sidewalk Labs' mobility plan is designed to evolve with the assumption that self-driving vehicles can form the backbone of the ride-hail system by roughly 2035. Self-driving fleets can enable cities to eliminate curbside parking, among other street design changes, reclaiming space for a safe and highly pedestrianized public realm.

Sidewalk Labs' 10 self-driving principles

Sidewalk Labs has identified a set of core principles and assumptions about the future of urban mobility to guide planning for the Sidewalk Toronto project.

Technology

1. Self-driving vehicles, drones, and robots will likely be commercially feasible and regulatorily viable in the next 10 years. Therefore, Sidewalk Labs' focus is not on fostering the adoption of these technologies but on shaping service patterns to optimize for urban quality of life.
2. The marginal cost of transportation will head towards zero as robotics eliminate labour costs associated with mobility. As a result, policies that charge a price for road use will be a powerful tool to shape travel decisions and alleviate congestion.
3. As freight vehicles become self-tracking and self-loading, delivery systems will require shipping containers themselves to have advanced capabilities, such as location awareness and security.
4. It will be increasingly important to take emerging travel technologies, such as low-powered vehicles, into account when planning a neighbourhood, to ensure they can be accommodated in a way that improves quality of life.

Design

5. Design that improves walking and biking will be especially powerful in a dense urban neighbourhood, given the benefits of active transportation on individual health, the environment, and public space.
6. Cars and vans will never be able to replace high-volume transit on key routes in dense areas. In lower-density areas that cannot justify frequent rail and bus transit, the use of low-cost, on-demand systems that encourage shared rides could be prioritized.
7. Ride-hail and delivery services will continue to displace vehicle ownership and traditional retail patterns. Because these services thrive on point-to-point operation, managing curb space will be critical to the overall efficiency of the street network.

Policy

8. Personal car ownership will persist, even if self-driving technology radically lowers the cost of hailed rides, because owning a car in a major city is not a decision people make based on a detailed cost-benefit calculation; thus, policy will need to shape car-ownership patterns.
9. New vehicle technologies — from scooters to self-driving cars — will challenge existing government policies and infrastructure. Governments need policy tools that give them a measure of control over these technologies.
10. Self-driving vehicles will not necessarily be electric or connected when introduced by the market, so policies that encourage these features may be needed to fulfill the overall promise of new urban mobility.

Goal 1

Harnessing New Mobility and Self-Driving Technology

Encourage shared use of ride-hail services

By many measures, ride-hailing services have been a major advance. By making high-quality taxi service available across the city, even in areas of medium or low density, ride-hailing enables more households to cut car trips or give up a car entirely, eliminates traffic related to searching for a parking spot, and reduces drunk driving. The technology can also match multiple riders along the same route, making it easier to share rides, which saves riders money while reducing environmental and congestion impacts.

But the rise of ride-hailing has been controversial. Many large cities[51] are reporting declines in transit ridership, a trend that some researchers attribute to increased ride-hailing trips. Studies have suggested that the enormous fleet of ride-hail vehicles generate new traffic congestion from the proliferation of pick-ups and drop-offs, creating another problem that cities need to solve. And the promise of sharing rides as an antidote to urban congestion has lagged, because shared-ride users often switch from non-auto modes of transportation.

As self-driving technology improves, the per-trip cost of a taxi service will be no more expensive than the per-trip cost of travelling in a private car, since the largest cost of existing taxi service is paying the driver. While the labour implications of this shift should not be minimized, it also means that people will be able to hail a ride for a much lower price than they can today and will experience shorter wait times. Researchers in Europe and the U.S. have estimated that self-driving fleet services could cost the equivalent of $0.23 to $1.27 per kilometre,[52] making them more affordable than existing ride services. At the same time, cheaper rides could also induce new ride-hail demand at the expense of more sustainable modes of transportation.

Sidewalk Labs seeks to maximize the mobility benefits of ride-hailing through staging areas, pick-up and drop-off zones, and shared-ride pricing. These initiatives aim to ensure that self-driving technology achieves the goals of expanding access to the city without a car, reducing household costs, and recapturing parking space for more vital public uses.

With self-driving fleets,

6.7%

of all IDEA District trips would be hailed rides.

Priority pick-up/ drop-off zones

Sidewalk Labs' approach to ride-hailing begins by designing staging areas for shared fleets or taxis. By providing a known hub where drivers and passengers can meet, drivers would be discouraged from cruising local streets for hails, without impacting passenger wait times.

As a related effort, Sidewalk Labs plans to design streets with passenger pick-up and drop-off spaces, which would facilitate ride-hailing and minimize the congestion that occurs when for-hire vehicles block traffic or double-park. These flexible spaces — or "dynamic curbs" — can respond to real-time traffic conditions. For example, during times of heavy traffic, dynamic curbs can be priced high, encouraging travellers to make other trip choices, such as public transit or bike-share. A real-time mobility management system (described on Page 84) can coordinate pick-up and drop-off spaces and set prices based on congestion.

During light traffic, dynamic curbs can be repurposed for community space or gatherings, with these changes indicated via lighted pavement. Lights in pavement are not a new technology. Airports have used lights inserted in their runways[53] to direct plane traffic since the 1940s. More recently, as the price of LEDs has dropped, cities have begun to experiment with how lights can help direct pedestrian[54] and cyclist[55] activity. Pavement lighting enables dynamic curbs to communicate changing street space allocations on-the-fly, helping neighbourhoods recapture flexible street space for public use in a clear and safe way.

These benefits increase with self-driving technology. A self-driving fleet can be directed by a mobility management system to a remote staging area, then summoned in appropriate quantities to meet real-time demand in local pick-up zones. This approach would save valuable space for buildings and the public realm, keep the streets clear of unnecessary traffic, and help eliminate cruising while maintaining a reliable supply of on-demand vehicles.

Priced to share

The other key piece of Sidewalk Labs' ride-hail strategy is to propose the use of charging and subsidies to encourage alternate trip choices and shared rides. This proposed pricing would take two forms: dynamic curb pricing for all vehicles, and charges and incentives for ride-hail vehicles using the Sidewalk Toronto project's specially designed local streets.

Technical spotlight

How Sidewalk Labs plans to encourage electric vehicles

A key part of the Sidewalk Toronto project's sustainability strategy is to shift to electric vehicles for as many trips as possible. The mobility plan would encourage a transition to electric vehicles (EVs) in several ways.

Electric light rail.
The first and most important is to reduce automobile use overall. The extension of the light rail would ensure that about 60 percent of travel to and from the IDEA District occurs by an all-electric light rail vehicle, which is even less energy-consuming per ride than an electric automobile.

Shared vehicles.
The second approach is to deploy a fleet of shared automobiles on the site, available to residents and on-site workers who have the neighbourhood's integrated mobility package. Travel models project that up to half of all resident auto use would involve these vehicles. Since the provision of these vehicles would be curated by the proposed Waterfront Transportation Management Association (see Page 86), it could be required that all such vehicles be electric.

Pricing and charging incentives.
For those residents who still own cars in Quayside, the WTMA could promote EV adoption in several ways. The off-site parking would offer EV charging, which can easily be managed because the lots will have attendants and most vehicles using those lots will not be used every day. Because it would control parking, the WTMA could offer discounts to parking fees for EVs owned by residents and employees, providing an incentive for drivers to switch.

For employees, visitors, and ride-hail vehicles, the WTMA could also use both pricing and charging to encourage EV adoption. In the hourly parking spaces at the mobility hub, 25 percent of all spaces would be equipped with chargers, with the ability to increase that number with demand; most of these charges would be fast chargers (Level 2 and 3). The WTMA could also choose to offer discounts on parking and curbside charges to EVs.

Self-driving vehicles.
The full scale of the IDEA District offers several additional opportunities to further increase EV adoption. One is the transition to self-driving vehicles, which should be all-electric; as use of these vehicles increases, the number of electric self-driving vehicles should increase as well.

A second opportunity is the area's greater size, which enables the WTMA to encourage changes in the ride-hail vehicles that serve the area. At that scale, WTMA could require that all ride-hail vehicles that want to be part of the mobility subscription package be EVs.

Finally, WTMA could adopt an approach that Waterfront Toronto suggested in the Villiers Island Precinct Plan: to prohibit non-EVs from entering the island.

A key remaining challenge to widespread EV adoption is that chargers themselves are difficult to site. One game-changing solution to charging would be to embed inductive chargers into the pavement, turning streets and parking spaces themselves into charging stations. A future evolution of Sidewalk Labs' paver technology is envisioned to include inductive charging.

1

Dynamic curb pricing.

As proposed, dynamic curb pricing would apply to all vehicle services and vary based on congestion in pick-up or drop-off spaces. These charges would include a low one-time charge to access the curb space and higher time-based charges for vehicles that wait longer than five minutes at the curb. The goal is to encourage people to consider alternative trip options or to share a ride and split the cost, as well as for vehicles to use the curb quickly and move on. Passengers who prefer not to pay a curb charge could be picked up or dropped off for free at a designated underground drop-off and pick-up area with access to numerous transport options.

2

Per-kilometre pricing.

Sidewalk Labs believes that a public mobility management entity should have the power to impose a per-kilometre charge on ride-hail vehicles using the Sidewalk Toronto project's specially designed local streets, if necessary to encourage people to share rides and to discourage operators from allowing vehicles to cruise streets without passengers.

A public entity that includes representation from the city would be responsible for proposing and administering any fees and would issue exemptions for riders with disabilities, the elderly, and low-income groups. (See Page 86 for more on this entity.) Additionally, the public entity could experiment with tools to ensure that ride-hailing vehicles work to support public transit; possibilities include offering subsidies for rides that begin or end at transit stations.

Sidewalk Labs could partner with the city and the Toronto Transit Commission on their upcoming pilot to design a meaningful test in Quayside. At the full scale of the IDEA District, Sidewalk Labs estimates that the increased convenience and affordability of self-driving fleets would result in nearly 7 percent of trips occurring by hailed rides.[56]

Goal 2

Harnessing New Mobility and Self-Driving Technology

Provide car-share and parking options for the occasional private car trip

From the daylong shopping trip to the long weekend away, there are some trips where even the best public transit systems and a variety of new mobility and ride-hail options are not sufficient. These types of trips are typically infrequent, but they place downtown households in a bind that often leads them to own a car they rarely use.

In Toronto, downtown households drive less on average than Ontarians overall — 5,600 kilometres versus 16,000 per year[57] — but most of the costs of owning a car are fixed regardless of how much a household drives; these include depreciation, insurance, and routine maintenance. The cost of parking is also very high[58] in downtown Toronto, ranging from $225 to $400 per month on average, and sometimes more. On the low end, for a family that drives only 5,600 kilometres per year, the cost of driving an owned car works out to roughly $2 per kilometre, which is about the same as an Uber or Lyft charge.

Car-share.

To help households use a private car on certain occasions without the need to own one, Sidewalk Labs plans to partner with a variety of on-site car-sharing and car-rental providers. It also plans to encourage a variety of vehicle types, such as minivans (helpful for tasks like buying used furniture) and cars equipped with car seats for children. Sidewalk Labs plans to require these vehicles to be electric; in exchange, these car-sharing services would have access to some of the few parking spaces within Quayside, making them convenient to residents.

On- and off-site parking.

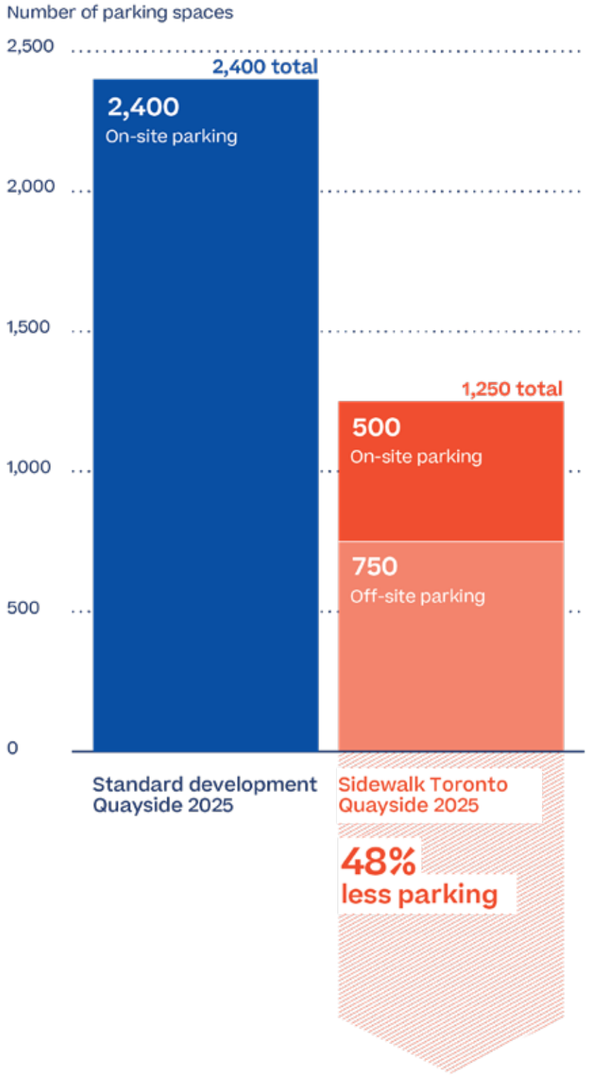
As with any neighbourhood, there will likely be some visitors, employees, and residents who still need to drive private cars into and out of Quayside, including people arriving from parts of the GTA that do not have easy transit connections to the neighbourhood. And while residents in Quayside should be able to meet almost all their daily travel needs without a car, some may have weekend travel needs that lead them to continue owning one.

To meet these needs, Sidewalk Labs proposes two approaches to parking:

In Quayside, short-term parking would be available in a 500-space underground garage. Roughly 100 spaces would be reserved for car-share vehicles; the remaining spaces would be priced to manage demand and discourage long-term use. This short-term garage would provide 15 percent of spaces with Level 3 electric-vehicle charging stations on opening day and would have the infrastructure to increase to 100 percent of spaces over time as electric vehicles become more common in Toronto. This approach stands in contrast to the nearly 2,400 parking spaces that would normally be provided in a residential development of this size.

48% less parking in Quayside compared to a typical development

Typical developments require significant on-site parking. By ensuring that Quayside residents, workers, and visitors can make nearly every trip without a private car, Sidewalk Labs can dramatically reduce the amount of parking required and shift the majority of spots to an off-site location.



For longer-term parking for employees and residents, Sidewalk Labs plans that off-site facilities be leased on available parcels very close to Quayside. These facilities would provide about 750 spaces, with on-demand pick-up and drop-off service between the off-site parking facilities and the proposed interchange near the intersection of Queens Quay and Small Street. Residents and employees would need to pay for this parking. The intention of this approach is to make off-site parking a reasonably priced option for people who occasionally use their cars without providing the on-site parking that encourages people to drive every day.

These parking facilities are also part of Sidewalk Labs' electric vehicle strategy. Owners of electric vehicles would pay a significantly discounted rate, and battery chargers would be provided at these off-site facilities. Based on current best practices, Sidewalk Labs' goal is for 30 percent of residents who own cars to switch to electric vehicles.

The switch from private car-ownership to electrified ride-hail fleets would not be meaningful at the Quayside scale; however, Sidewalk Labs expects personal car-ownership to be reduced significantly at the larger IDEA District scale. At such a scale, both of these parking facilities would be converted to accommodate the maintenance and staging of self-driving ride-hail vehicles.

The benefits to neighbourhoods would also be substantial, as off-site parking would dramatically reduce or eliminate the number of spaces normally located in buildings, freeing up space for housing or shared amenities.

Goal 3

Harnessing New Mobility and Self-Driving Technology

Make all trip options available in discounted mobility packages

Urban mobility services tend to be operated by a patchwork of public agencies and private companies, but city residents just want to get around. On any given week, a typical household in downtown Toronto uses a mixture of streetcar, subway, taxi, ride-hail, bike-share, and other services.

Some cities have started to tackle this fractured system with integrated fare technologies that enable people to pay for a variety of trip types. For example, Toronto's Presto card works on both GO commuter trains and TTC subways, streetcars, and buses, while in Tokyo, travellers can use a Suica card[59] to pay for a subway fare and a taxi (as well as purchase goods from station shops). Meanwhile, some digital navigation apps have started to display scheduling or purchasing options across many services, from bike-share to buses.

Sidewalk Labs' mobility vision includes ensuring that people see all their trip options at any given moment and pay for them using the same service. One component of this goal would be an integrated mobility package that includes a monthly subscription covering a wide range of services — a concept often called "mobility as a service" — including a TTC monthly pass, an unlimited Bike Share Toronto membership, access to electric scooters and other low-speed vehicles, and credits for rides with ride-hail or car-share providers. Sidewalk Labs expects a version of this package to be available to residents at a cost of $270 per month.[60]

Sidewalk Labs' mobility vision includes ensuring that people see all their trip options at any given moment and pay for them using the same service.

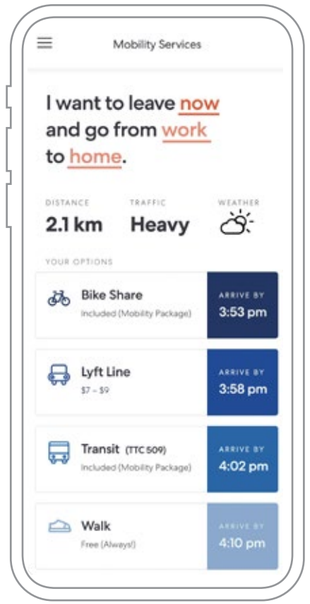
Another key component is making real-time information about mobility services and the transportation system available in open, standardized formats. This approach could result in a new integrated mobility app created specifically for the IDEA District that features all mobility choices in one place. Or, it could encourage existing third-party apps (such as Transit App or Citymapper) to offer their users services based on much more accurate and relevant information.

All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the "Digital Innovation" chapter of Volume 2, on Page 374.

Critically, Sidewalk Labs' data integrations would allow third-party mobility apps to understand the real-time price for each service. For example, residents with an integrated mobility package could see a light rail trip as "free," instead of showing the standard fare. The result would be a personalized, accurate representation of transportation options that encourages people to make trips that do not require a private car.

A development the scale of Quayside could help test and refine the capabilities of an integrated mobility service — and more importantly, present Quayside residents with an attractive new mobility package during move-in, a transition period when studies have found people are most open to new travel behaviours.

When deployed across the full scale of the IDEA District, an integrated mobility service would provide access to all the new and traditional mobility options that make it far easier for households to avoid owning a car in a downtown neighbourhood, and the more than $10,000-a-year cost associated with it.

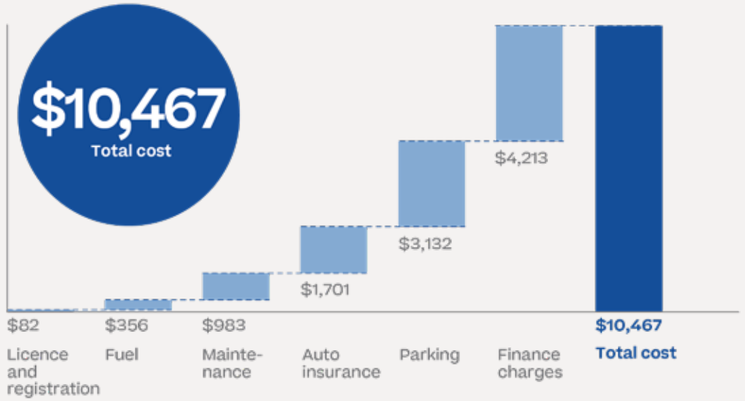


The integrated mobility package could be used through a new mobility app that shows travellers all their options in real time (above, an illustrative interface).

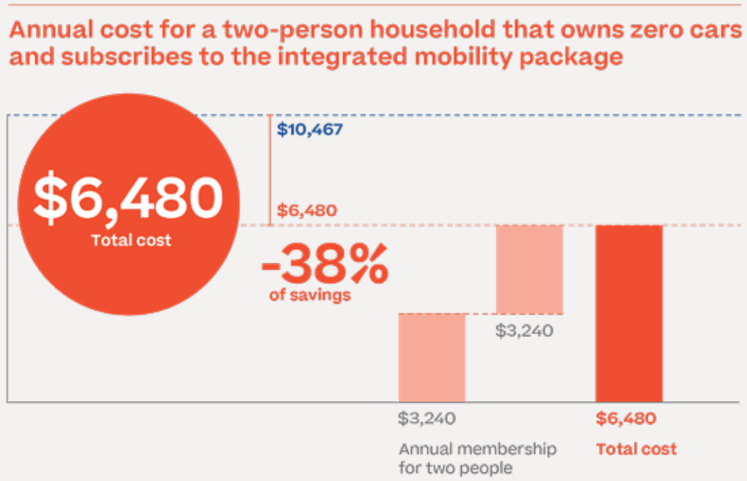
Saving $4,000 a year with new mobility options

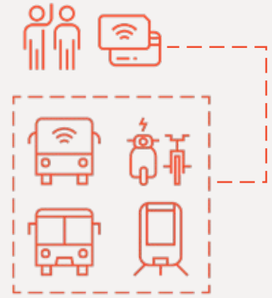
Sidewalk Labs' proposed integrated mobility package includes a discounted TTC pass, unlimited bike share, ride-hail credits, and other options for $270 a month. A two-person household that switched from owning a car to subscribing to this mobility package would save at least 40 percent on annual transportation spending, or roughly $4,000 per year — while still meeting projected travel needs. The actual savings would likely be greater, as households that own a car in downtown Toronto also currently consume some additional mobility services, such as public transit and hailed rides.

Annual cost for a two-person household that owns one car



Annual cost for a two-person household that owns zero cars and subscribes to the integrated mobility package





The integrated mobility package includes a discounted TTC pass (trains and buses), an unlimited Bike Share Toronto membership, access to e-scooters and other low-speed vehicles, and credits for rides with ride-hail or car-share providers for $270 a month.

Ch–1

Part 4

Reimagining City Deliveries and Freight

Key Goals

1
Establish a neighbourhood logistics hub for delivery, waste, storage, and borrowing services

2
Design a smart container for last-mile shipping

3
Deploy electric, self-driving delivery dollies

4
Connect underground delivery tunnels into buildings

The ability to have goods delivered quickly and reliably is an essential component of urban living — especially for households that do not own a car or have much storage space. And this ability is getting easier every day in cities like Toronto, thanks largely to online shopping. But the result is that there are now far more trucks on city streets. Canada Post's total domestic parcel volumes[61] rose 63 percent from 2007 to 2017, jumping 22 percent from 2016 to 2017 alone.

While delivery *feels* easier than ever to consumers, the delivery system itself is anything but simple. It is very difficult and expensive for shipments to go from a distribution centre to someone's door — a challenge often known as the "last mile" problem. These deliveries are almost exclusively made by trucks, many of which are too big for narrow city streets. Daytime customer demand means delivery trucks cannot simply travel overnight, but adding these vehicles to the road during peak travel times leads to traffic congestion and delayed deliveries, as trucks spend time looking for curb space. When no space is available and delivery timing is tight, they often double-park and incur a ticket.

Often, the least efficient part of the last mile is the final 50 feet. In urban areas, this final 50 feet covers the distance and time it takes for a truck driver to unload goods and complete the final handoff. Depending on where the delivery vehicle is parked, the last 50 feet can include the movement of goods by hand cart across a city's streets and sidewalks and can also involve elevator rides to a variety of recipients in tall buildings.

For all that trouble, people living in buildings without mailrooms or door service often miss deliveries — resulting in failed first, second, and even third delivery attempts, with the traffic congestion, pollution, and inconvenience that comes with them.

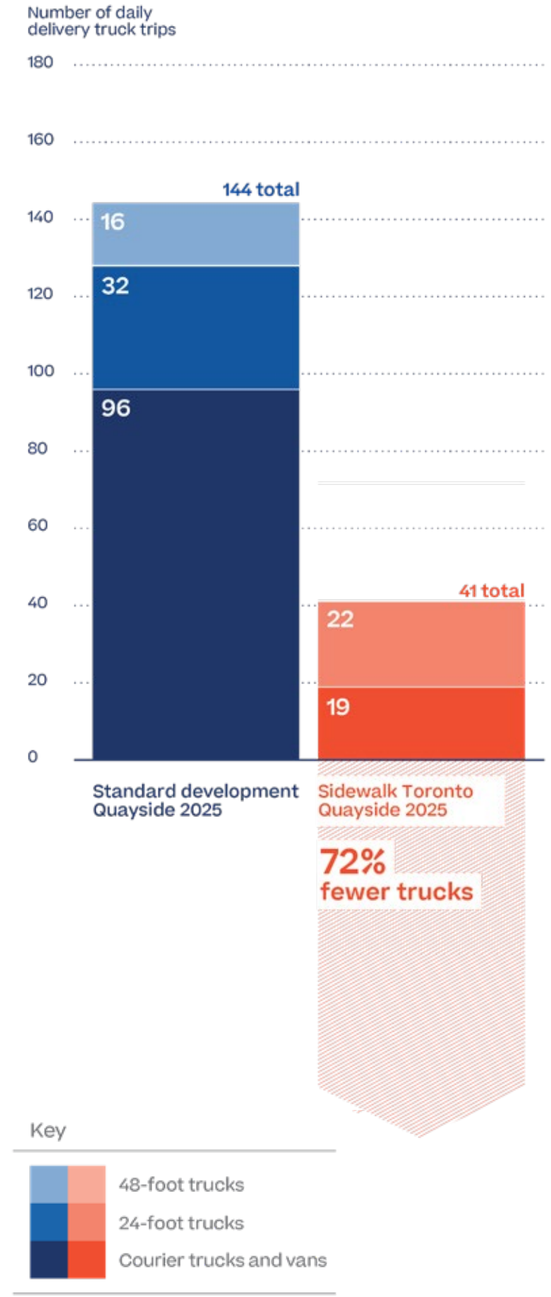
Sidewalk Labs has a comprehensive plan to address the "last-mile" challenges of urban logistics by creating a 24-hour neighbourhood freight system that dramatically reduces the negative impact of goods movement on city streets.

The plan begins by proposing to coordinate all deliveries (along with waste, storage, and borrowing services) at a new logistics hub on the perimeter of a neighbourhood to reduce unnecessary truck traffic on local streets. At this hub, nearly all packages would be transferred into new "smart containers" designed specifically for last-mile shipping, with these containers then travelling via electric, self-driving delivery dollies in a system of underground tunnels. This approach would enable all-hour delivery that avoids street disruptions and improves customer convenience at a lower cost to carriers, thanks to less time spent looking for parking, fewer tickets, and the opportunity to deliver full truck loads to the hub.

In Quayside, Sidewalk Labs proposes to implement several aspects of this system, including a local logistics hub, smart containers, and a tunnel network. But the neighbourhood's size prevents the system from generating enough revenue to sustain itself. Implemented at the full scale of the IDEA District, the system could become financially self-sustaining through a combination of shipment, storage, and waste-related hauling charges.

In Quayside alone, this system would reduce truck trips into the neighbourhood by 72 percent, along with reducing disruption to local roads and surrounding areas. These savings are achieved primarily through the consolidation of shipments into a single neighbourhood location. The beneficial impact would only get bigger when deployed at the full scale of the IDEA District.

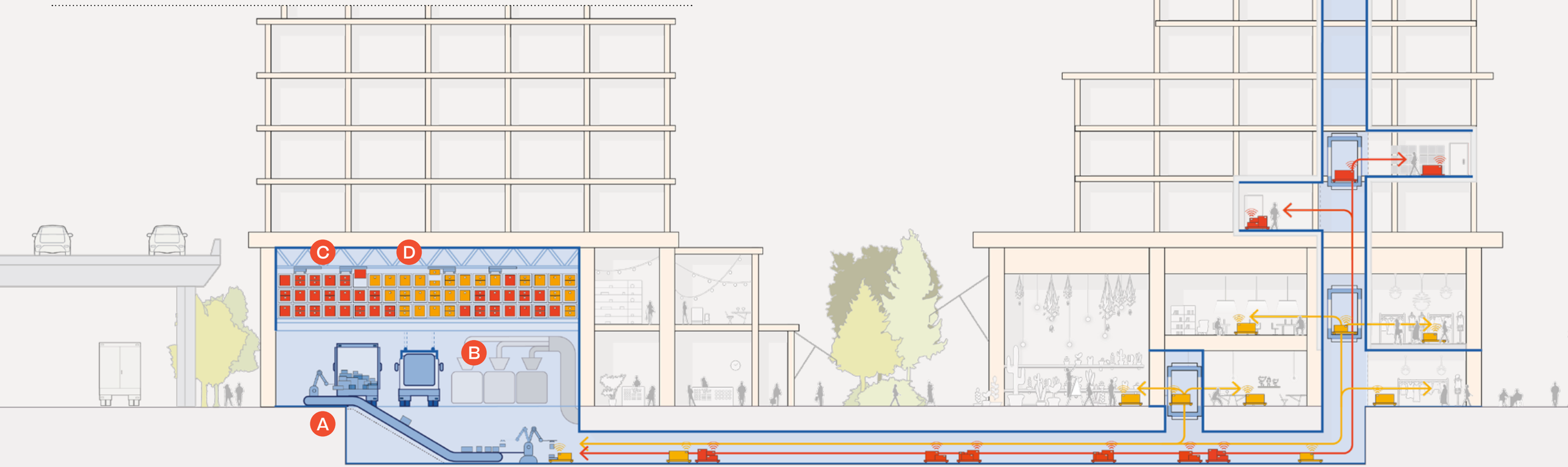
An underground freight delivery system could reduce truck traffic by 72%



How it works: The neighbourhood logistics hub

Centralizing inbound and outbound deliveries — along with coordinating waste, off-site storage, and borrowing — would dramatically reduce truck traffic on local streets.

Smart containers filled with parcels, storage, or borrowing items would be placed on self-driving delivery dollies and delivered to their final destinations via underground tunnels. Smart containers could be dropped off without fear of theft: they are trackable and unlockable only by way of a digital code shared solely with a recipient.



A The hub's **urban consolidation centre** would collect deliveries and prepare them for last-mile transport via underground tunnels that connect into buildings.

B **Waste** from three streams (organics, recycling, and landfill) would be transported via pneumatic tubes to the hub, making it the only neighbourhood stop for garbage trucks.

C **Off-site storage space** enables residents and businesses to store goods (such as seasonal items or inventories) and have them delivered on demand.

D A **borrowing library** of helpful items (such as power tools or sound systems) would be available for delivery across the neighbourhood.

The many ways to use a smart container

Delivery lockers

An efficient delivery locker system would act as a mailroom, offering a space where tenants could easily access mail and packages.

Off-site storage

Residents could use storage facilities for things such as seasonal clothing and equipment, with smart containers retrieving and delivering stored items on demand.

Door-to-door convenience

For people with accessibility needs, or for items that are large or heavy, smart containers could travel directly to a door for drop off or pick up.

Goal 1

Reimagining City
Deliveries and Freight

Establish a neighbourhood logistics hub for delivery, waste, storage, and borrowing services

Sidewalk Labs' proposed freight system begins with a neighbourhood logistics hub for deliveries, waste, storage, and borrowing services.

A neighbourhood hub allows for carriers to bundle deliveries and drop them off at one neighbourhood location, saving time and reducing the impact of truck trips on local streets. A 2017 study of a delivery consolidation centre[62] in Copenhagen found that it reduced truck kilometres by roughly 65 percent and emissions by 70 percent. These systems also help small retailers compete with larger ones by reducing the cost of last-mile distribution through savings related to time, fuel, and parking tickets.

To date, many such centres have failed to generate sustainable revenue. One exception is in the Dutch city of Nijmegen, which has succeeded by becoming a logistics hub that offers additional paid services on top of freight consolidation, including storage,[63] home-delivery, online-order fulfillment, and clean waste collection. Building on this successful example, Sidewalk Labs' hub plans to house four types of freight-related facilities.

In Quayside,
95%
of deliveries would go through the urban consolidation centre.

1

Urban consolidation centre.
Sidewalk Labs' proposed logistics hub would feature an "urban consolidation centre" that consolidates inbound and outbound deliveries in a single place, just as the mailroom at a large university campus might serve multiple buildings.

The urban consolidation centre would allow delivery carriers, such as UPS, to deliver to one location instead of to each door in the neighbourhood. All inbound parcels would be received at the centre and then, as in a traditional distribution centre, sorted by address. Finally, items would be placed into smart containers and sent to their final destination within the neighbourhood. The same would be true for inbound smart containers transporting parcels for pickup by carriers.

This centralization would significantly reduce the number of trucks coming into the neighbourhood because carriers would be able to consolidate all of their deliveries into fewer trucks. It would also improve conditions in and around the neighbourhood: no more trucks looking for parking, failed delivery attempts, excess fuel burning, or lost time. And with consolidation centres, carriers can unload an entire vehicle and collect multiple outbound deliveries, ensuring that trucks are moving as efficiently as possible and not driving empty.

In Quayside, roughly 95 percent of all residential and commercial deliveries could be handled by this facility.[64] Oversized and overweight cargo, such as a sofa or something requiring special handling, would be delivered directly to the destination. Sidewalk Labs proposes to require traditional trucks to pay for a special permit to enter Quayside, with discounts for making deliveries during the night, operating electric vehicles, and using loading docks instead of the curb. (A new public entity would manage these payments; see Page 86 for details.)

2

Waste.
The proposed neighbourhood logistics hub would also serve as the neighbourhood's waste consolidation site. Waste would arrive through a number of routes. Landfill, organics, and metal/glass/plastic would arrive via underground vacuum tubes. Recyclable cardboard and other items that do not travel through the vacuum tube system would arrive through the neighbourhood freight system. Providing a one-stop pick-up for waste would reduce the presence of garbage trucks on local streets. As with exceptional deliveries, oversized waste would require direct pick-up, triggering a permitting process.

See the "Sustainability" chapter of Volume 2, on Page 296, for more details on waste.

3

Off-site storage.
The logistics hub would also provide an on-demand storage service for residents who prefer not to keep certain items at home. Residents can store items at the storage facility just as they would in traditional city storage units, but they can order their items for immediate delivery using a digital app — with a standard of responsiveness that no current service offers. The app would allow users to see what items they have in storage by providing a personalized inventory list with photos or accessible audio descriptions for easy retrieval. This service could include short-term storage for bulky cookware, luggage, and other items used occasionally and longer-term storage for items used seasonally, such as winter clothes or skating equipment.

Businesses looking to reduce stockroom clutter can use this storage service as well. As a result, retail stores can act more like showrooms, with limited items inside the store and excess products stored off site. Because the storage facility would be co-located with the shipping centre, products can be immediately shipped out to customers who live in Quayside (via underground tunnels) or to those who live elsewhere (via trucks). That means people can shop throughout the neighbourhood without having to carry their purchases with them, freeing them to arrive via transit or bike instead of a car.

4

Borrowing library.

Finally, the logistics hub would contain a peer-to-peer “Library of Things” service for neighbourhood residents and small businesses who prefer to borrow or rent items rather than buy them. Similar services that exist today, such as the Sharing Depot, often rent out items that are expensive, bulky, or infrequently needed, such as power tools, sound systems, and grills. The library could house these items and rent them out for a fee. A true sharing economy would allow the IDEA District to be more convenient, sustainable, and affordable, enabling people to live comfortably in apartments with less storage space (and thus lower rent).

In Quayside, the entire logistics hub is planned to be 200,000 usable square feet, capable of accommodating over 18,000 daily parcels, with all activity other than loading docks located underground. The hub would be underneath the buildings on the northwest side of the neighbourhood. By having all the logistics activities take place below ground, the hub would seamlessly integrate into the neighbourhood, with a ground floor that features active “stoa” spaces. At the proposed full scale of the IDEA District, such a hub could be located at the northern edge of the Keating Channel area to facilitate access to other geographies.

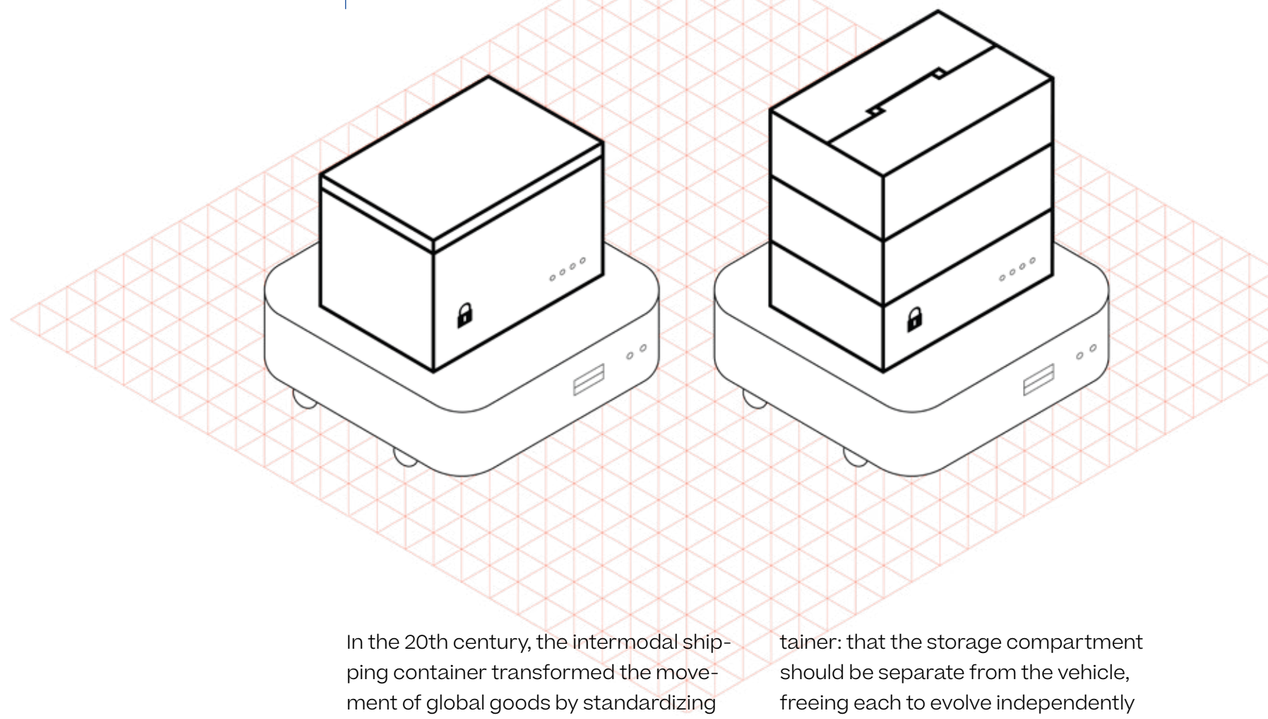
See the “Public Realm” chapter of Volume 2, on Page 118, for more details on stoa.

In Quayside, the entire logistics hub would be capable of accommodating over 18,000 daily parcels, with nearly all activity occurring underground.

Goal 2

Reimagining City Deliveries and Freight

Design a “smart container” for last-mile shipping



In the 20th century, the intermodal shipping container transformed the movement of global goods by standardizing the shape and size of an otherwise infinite variety of goods being shipped and by separating the cargo container from the vehicle itself. As a result, shipping containers can now travel around the world by truck, boat, or rail without unloading their contents.

While the shipping container solved many problems associated with long-haul freight, last-mile delivery still relies on the cardboard box. Various innovations are currently being tested, ranging from van-sized, self-driving trucks to robots that travel on sidewalks. But all of these ideas have incorporated the cargo into the vehicle itself, which misses the core insight of the long-haul shipping container: that the storage compartment should be separate from the vehicle, freeing each to evolve independently over time.

Inspired by the shipping container, Sidewalk Labs plans to develop standardized “smart containers” as the 21st-century urban equivalent for last-mile delivery.

At the neighbourhood logistics hub, goods would be scanned and sorted into smart containers, while still in their original packaging (nothing is opened). The smart containers would be designed to be able to carry the vast majority of standard-size packages. They can be filled with a single package or filled with several packages, depending on the destination and delivery urgency. If a receiver has multiple packages arriving in one day,

the container would wait until it is filled up before making its way out of the logistics hub in order to be as efficient as possible. For urgent delivery of an item that may be perishable or that has other immediate delivery needs, a smart container would leave as soon as the package is placed inside.

Smart containers could be handled by a variety of delivery vehicles — from cargo bikes to traditional trucks to self-driving vehicles — so that cities that have not yet embraced self-driving transportation can still use them. These durable containers would be stackable, enabling them to function as lockers and to be placed easily onto delivery vehicles. They would also be embedded with location-based capabilities to track movements.

A smart container is not only for mail and package delivery; it can be used to move other items within the logistics hub, including waste, storage, and borrowing items. After a smart container delivers a parcel or stored item, recipients can send back the container filled with a new type of cargo; for example, after receiving a package, residents can then send out their storage items in the same container. This makes for a highly efficient "backhauling" system, which reduces the amount of time containers travel while empty. The design of these containers would allow for the safe and healthy handling of multiple types of cargo through the use of liners, inserts, and innovative cleaning methods.

In addition to improving package logistics, the smart container has a number of features that would empower residents and businesses to receive shipments on their own terms, thereby eliminating missed deliveries.

Flexible scheduling.
Using an associated delivery app, recipients can reroute containers if they prefer to have their items delivered to a location other than the one it has been scheduled to arrive at, all the while knowing exactly what is inside and where the container is located. The app also allows recipients to provide container access to approved friends, family, or associates, in case they need items to be received while they are unavailable. With an integrated app, users can also request a container for pick-up when outbound items are ready to go to waste, borrowing, storage, or delivery facilities.

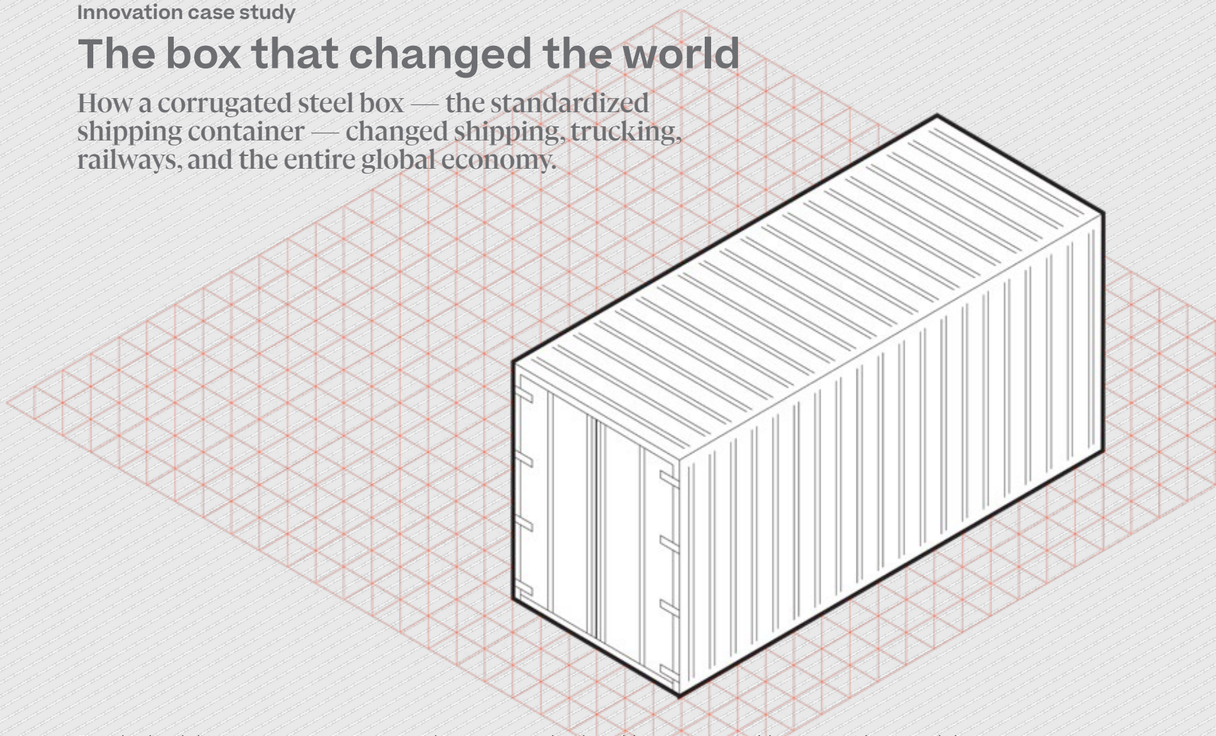
Delivery security.
The smart container's digital lock enables it to be safely left in a building's mailroom or locker system — or even at a recipient's door. Instead of needing someone to be present for a delivery, the container acts as a permanent receiver; all it requires is a space where it can be placed.

Package tracking.
Mail and package tracking would be managed through software that integrates with existing carrier software so receivers can track their items from origin to final destination. Confirmation signatures and other delivery requirements would be handled through a profile set up by the recipient. Package recipients can unlock the container with a code. And if the container makes an unauthorized movement, suggesting a theft, its location transmissions would alert the system.

Innovation case study

The box that changed the world

How a corrugated steel box — the standardized shipping container — changed shipping, trucking, railways, and the entire global economy.



Standardized shipping containers — corrugated steel boxes measuring 2.44 metres (8 feet) wide, 2.74 metres (9 feet) high and 12.19 metres (40 feet) long — can be seen everyday on highways, waterways, and railways. As unremarkable as they might seem today, shipping containers revolutionized global trade and the movement of goods, creating economies of scale like few other innovations ever have.

As late as the post-World War II period, freight arriving by ship into city ports was packed in barrels and crates and still had to be handled manually: shipments were first unloaded into dry dock and then loaded back onto trucks or trains (in appropriately named "boxcars"). The process required lots of people, time, and space (warehousing) to complete. And it was open to many forms of abuse. Theft was rampant. Bribery was also a problem, as firms paid operators under the table to make sure their cargo was first on the trucks.

The standardized container, introduced in 1956[65] by North Carolina trucking entrepreneur Malcom McLean, made it possible to move whole containers between sea, road, and rail simply by using a crane. No container ever needs to be unpacked until it reaches its final destination. The result has been a steep cost reduction and efficiency gain. McLean's first container ship cost just $0.16 USD per tonne to load compared with roughly $5.83 per tonne for a ship loaded by hand. In 1965, dock workers typically[66] transferred some 1.7 tonnes of freight per hour onto ships; within five years they were loading 30 tonnes per hour.

The containers ensured that freight always moved as fast as its vessels could carry it; with minimal slowdown for transfer, the need for warehousing, especially dockside, was dramatically reduced. The sight of dozens of trucks carrying standardized containers is really the sight of the economy's rolling, decentralized warehouse-on-wheels.

Ironically, the standardized container also represents the origin of the "last-mile problem," the challenge of efficiently dispersing individual packages to their final destinations, currently the most costly step. Containerization successfully solved all the middle-mile challenges. If containerization principles were applied on a neighbourhood scale, they have the potential to help fix the "last-mile problem" as well.

Goal 3

Reimagining City
Deliveries and Freight

Deploy electric, self-driving delivery dollies

Today, there are a growing number of electric vans and cargo bikes in urban areas, but these vehicles make up a small fraction of delivery fleets. Some companies have started to explore delivery robots, but as noted on Page 77, these vehicles are typically designed to act as a container on wheels — functioning as a single unit.

To transport its smart containers between the logistics hub and buildings, Sidewalk Labs plans to deploy electric self-driving delivery dollies that resemble a large Roomba. These dollies can transport individual smart containers or a set of containers stacked to form a mobile locker system.

The self-driving delivery dollies must have communication capabilities that help them navigate from Point A to Point B, reroute when necessary, and "call for help" if any issues arise. Like the smart container itself, the self-driving delivery dollies are connected to the recipient's user interface for tracking the location of a container, scheduling pick-ups, and more.

Sidewalk Labs does not plan to create self-driving delivery dollies itself but rather plans to work with third-party vendors to identify or develop a design that meets the container's specifications.

In Quayside, self-driving delivery dollies would transport smart containers via underground tunnels (described more on Page 82). The beauty of separating the container from the delivery vehicle is that the container can be left at its destination safely and securely without the receiver being present.

A 24-hour underground neighbourhood freight system would dramatically reduce truck trips and pollution — while maintaining customer convenience.

Goal 4

Reimagining City
Deliveries and Freight

Connect underground delivery tunnels into buildings

To help improve the last 50 feet of urban freight, Sidewalk Labs plans to create an underground delivery network linking the logistics hub with the basements of residential and commercial buildings. The tunnel network would allow for 24/7 delivery activity and would help people and businesses get their shipments fast, without having a negative impact on neighbourhood street life.

In Quayside, as planned, these delivery tunnels would be two metres in diameter, allowing for multiple self-driving delivery dollies with a variety of smart container configurations to travel to and from the logistics hub. This system would help solve some of the biggest hurdles facing delivery robots today, such as bad weather conditions, uneven surfaces, and road or sidewalk congestion.

Sidewalk Labs proposes to require that each building be designed to connect with the tunnel system so self-driving delivery dollies carrying smart containers can enter. These dollies would have the ability to take freight elevators to common spaces, including first-floor lockers for package delivery.

In first-floor mailrooms, self-driving delivery dollies could stack smart containers together to form a type of delivery locker system. Receivers could collect or ship items at their convenience by removing or placing deliveries into the containers. In common refuse rooms, self-driving delivery dollies could collect smart containers with outbound waste not capable of using the pneumatic tube system. For deliveries that require direct-to-door transportation (for reasons such as weight, accessibility concerns, or type), as well as for storage and borrowed items, self-driving delivery dollies would be able to transport containers via freight elevator to a recipient's door.

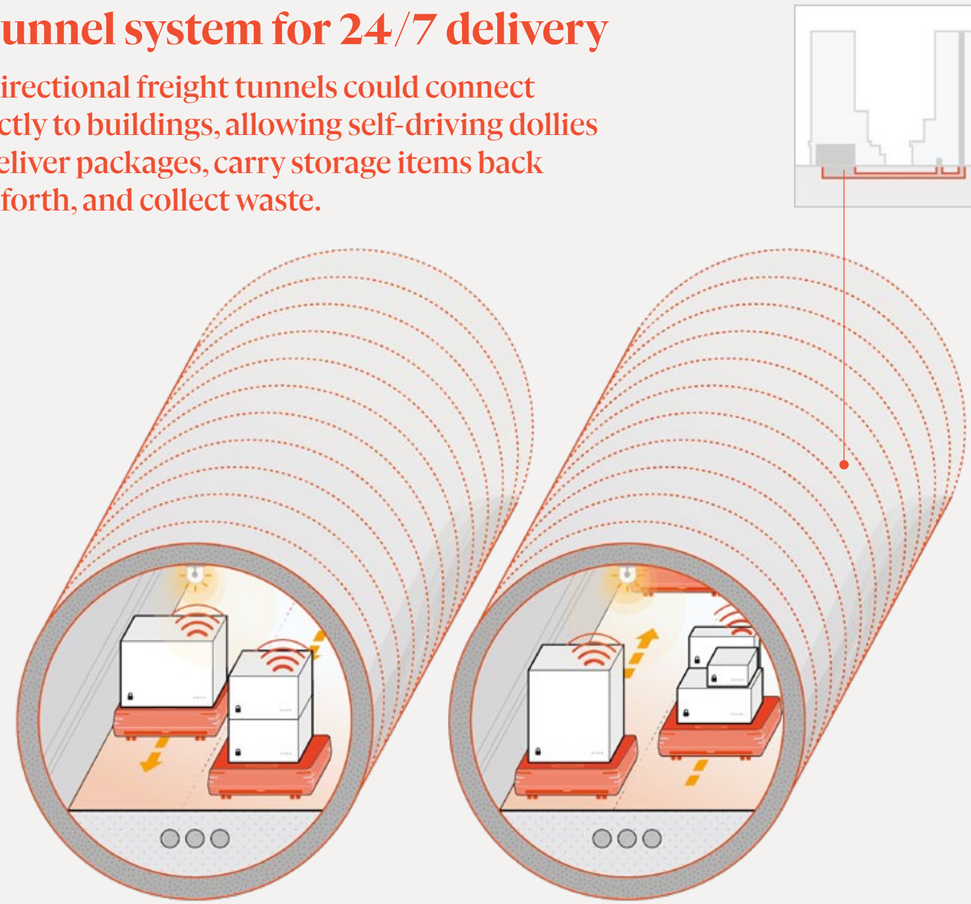
In addition to freight tunnel access, all buildings would have a traditional loading dock, which would only be used in occasional circumstances to allow exceptions for standard delivery trucks. As noted on Page 75, these exceptions would require a special permit.

Drone delivery.

The most radical change to delivery services over the next decades is likely to be the use of drones for local deliveries, which is already showing promise for high-value deliveries in low-density areas. In dense downtown areas like Quayside, drones raise a number of issues, from noise to collisions to interference with flight paths (such as those of the planes coming in and out of Toronto's Billy Bishop Airport). It is likely that over time these issues will be addressed, although given the novelty of this innovation, the time frame is impossible to predict. To make it possible to use this technology when it is safe and ready, Sidewalk Labs proposes to require that each building rooftop be designed with landing pads for drones,

A tunnel system for 24/7 delivery

Bi-directional freight tunnels could connect directly to buildings, allowing self-driving dollies to deliver packages, carry storage items back and forth, and collect waste.



making sure the designs are flexible so they can evolve along with drone technology. When they are ready for use in Quayside, drones could be incorporated into the delivery system for urgent or premium deliveries.

Management and economics.

Making a neighbourhood logistics system work is not just a technological challenge but also a managerial one. The freight service would need to be managed as an integrated system, operating the urban consolidation centre, vehicle fleets, and storage facilities. The proposed freight system would obtain revenues from several sources: residents would pay to use its off-site storage; building managers would pay for any waste removal using its services; local retailers would pay it to make deliveries and store inventory; and, at the full scale of the IDEA District, shippers would also pay it to make deliveries because it would save them the cost of the last mile.

The freight-system manager would need to pay building owners rent for the space used (such as the logistics hub or mailroom space), although that rent would take into account the overall value the system creates for the neighbourhood, including both convenience and reductions in truck traffic. The proposed freight system would operate under a contract to the entity that would oversee overall mobility management for the neighbourhood.

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Part 5

Improving Mobility Management

Key Goals

1
Establish a new entity to coordinate the entire mobility system

2
Deploy a real-time mobility management system

The initiatives described so far in this chapter outline fast, comfortable, and affordable ways of traveling without a private car for nearly every trip. In practice, however, things can play out very differently, with small disruptions having the potential to multiply into systems-wide upheaval.

A concert or event might flood transit with additional passengers for a single hour, leading to overcrowding and delays that impact rides throughout the evening. A fierce storm might cause some bike commuters to choose ride-hail options, creating a sudden influx of users. Extending a "walk" signal so a pedestrian can safely cross the street in one location might cause traffic congestion somewhere else.

Cities typically struggle to tackle these daily challenges because each trip mode is controlled by a different agency or company, each with its own data and priorities. City transportation departments are in charge of the streets; a separate mass transit agency usually runs the subways, buses, and streetcars; and private companies might operate bike-share programs, taxi fleets, or ride-hail services.

To add to the challenge, the decision to implement policy tools that might improve coordination, such as curb pricing, often rests with yet another agency. New infrastructure advances that could also help, such as adaptive traffic signals, are often beyond an agency's budgetary reach.

The result is that in cities around the world, fundamentally interdependent systems have become fragmented, leading to widespread frustrations and costs. For all of the mobility initiatives laid out in this chapter to succeed in reducing car trips and providing safe, convenient, and affordable options, they must work in concert.

Sidewalk Labs proposes that a new public entity called a Waterfront Transportation Management Association (WTMA) coordinate the transportation system in the IDEA District by deploying a mobility management system.

Key Term
WTMA
Waterfront Transportation Management Association
A public entity coordinating the transportation system in the IDEA District.

In a small neighbourhood the size of Quayside, holistic management can have a meaningful but modest impact on mobility goals. Responsive traffic signals can hold a crossing signal for pedestrians or cyclists at isolated intersections. Trip data can inform traffic decisions, such as giving green priority on Queens Quay for the light rail. Curb pricing can encourage people onto vehicle alternatives, such as bike-shares.

But to ensure that people have convenient and reliable alternatives to private cars, a mobility management system must be able to evaluate a substantial number of routing and trip options. For example, if a street is clogged, a real-time mobility management system can direct vehicles to an emptier parallel street. These small variations in route can add up to big time savings. Such improvements could increase further with the arrival of self-driving vehicles, which can receive information directly from mobility management systems.

As a result, in Quayside, the effect of management would be limited, as there are simply not enough intersections to balance safety, congestion and trip choices. But when deployed at the full scale of the IDEA District, this comprehensive mobility management system can process travellers with greater efficiency. The benefits include processing six times as many curbside pick-ups and drop-offs as a typical one-hour metered curb, managing adaptable pavement to create an expandable network of bike lanes to meet year-round demand, and setting parking prices that decrease the number of private car trips.

A comprehensive mobility management system could balance safety, congestion, and trip choices to ensure that people have convenient alternatives to private cars.

Goal 1

Improving Mobility Management

Establish a new entity to coordinate the entire mobility system

The WTMA would:
- → Implement **objectives**
- → Oversee **planning, operations, and maintenance**
- → Manage **daily movement patterns**

To help Toronto's waterfront achieve its mobility goals around safety, affordability, and convenience, Sidewalk Labs proposes establishing the WTMA as a public entity tasked with coordinating the transportation system in the special innovation zone.

In keeping with Sidewalk Labs' objective of undertaking new approaches to urban problems, the WTMA would allow the overall mobility performance of a neighbourhood to be managed in an integrated way. In Toronto, as in most cities, this management is done piecemeal: one entity oversees parking, another manages traffic signals, and yet another sets the price of transit rides. But these efforts are all highly integrated, and all shape the way people are able to get to and from the neighbourhood.

The WTMA would be responsible for delivering mobility services and innovations in the IDEA District, including:

- Creating a mobility subscription package
- Deploying a holistic mobility management system
- Managing and setting prices for the curbside and parking systems
- Procuring and operating new technologies, such as adaptive traffic signals, dynamic pavement, freight and deliveries, or other third-party systems and apps
- Integrating systems with third-party navigation apps
- Allocating space across the needs of mobility, access, safety, and the public realm
- Reporting on performance targets related to congestion, mode share, and customer service

Sidewalk Labs proposes that the WTMA's operations be financed by fees in a way that ensures the entity is self-sustaining. Potential sources of revenue include parking fees, curbside pick-up/drop-off fees, road user fees for ride-hail vehicles using the Sidewalk Toronto project's specially designed local streets, and charges for mobility services to residents and employees (which could be paid by individuals or included in rents and home owner association fees).

Sidewalk Labs proposes that the WTMA have three primary tasks: implement the guiding objectives of the transportation system; oversee planning, operations, and maintenance; and manage the movement of people and goods on a daily basis using data about the system.

In Focus

The three roles played by the WTMA

By incorporating policy, planning, and daily management within a single entity, the proposed WTMA would enable the IDEA District to achieve Toronto's mobility goals around safety, affordability, and convenience.

1

Implementing policy objectives

Clear policy objectives are critical to a well-functioning transportation system, because the coordination of such a complex system inevitably requires numerous trade-offs at every moment. The WTMA would be tasked with determining transportation policy objectives, guided by the city, local agencies, large employers, and community groups. These policy objectives would be used to guide the mobility management system for the IDEA District.

Sidewalk Labs proposes that the WTMA apply several guiding principles to the system to achieve the objectives of a safer, more convenient transportation system that provides a range of options for all trips:

Vision Zero.
A Vision Zero safety policy prioritizes the safety of people over the movement of vehicles, consistent with the policy adopted by the City of Toronto.

Shared mobility.
Shared mobility prioritizes high-occupancy vehicles over single-occupancy car use. In practice, this type of approach could be implemented through road-pricing mechanisms, such as a subsidy applied to shared trips or through a congestion charge.

Person throughput.
Transportation experts refer to the total number of people going through an intersection as "person throughput." An objective based on person throughput could prioritize moving as many people as possible, agnostic of any particular mode. For example, a single packed transit vehicle would get signal priority at a traffic light over a line of empty taxis.

2

Overseeing planning, operations, and maintenance

The WTMA would handle a range of duties, such as administrative tasks (e.g. contracting with a microtransit shuttle operator and issuing fare subsidies to those who qualify), operations (such as operating traffic signals), and maintenance (such as replacing pavement or coordinating utility work).

The WTMA's essential duties include:

- **Maintaining and replacing** the modular pavement system (including heating or lighting)
- **Providing** travel credits or subsidies across all modes, including bike-share or ride-hail services
- **Operating** hardware and software for parking, curb, and traffic management
- **Setting and enforcing** parking, curbside, and road-usage fees
- **Setting** speed limits for speed-separated streets

Additional management duties that could be performed by the WTMA or covered via agreements with public-sector agencies or third-party contractors include:

- **Managing** street closures for construction or events
- **Handling** data in accordance with all applicable laws, and subject to the authority of the Urban Data Trust proposed for the area
- **Creating** a user interface or app for trip planning and subsidies (or integrating into third-party tools)
- **Clearing** snow and debris (beyond heated pavements)
- **Constructing and financing** roads or parking facilities

3

Managing the system

The WTMA's third primary role would involve using an advanced mobility management system to coordinate mobility across the waterfront in line with its policy objectives. The required capabilities of this system are described more in the following section.

Goal 2

Improving Mobility Management

Deploy a real-time mobility management system

To achieve core mobility goals of safety, affordability, opportunity, and convenience, the WTMA would need to deploy a mobility management system capable of coordinating all streets, signals, lanes, and trip options in line with local objectives. The essential functions of such a system would include:

- Understanding how people are using the entire system in real time via data on things like traffic volume, vehicle speed, transit delays, emergency dispatches, and even weather patterns
- Analyzing these travel patterns in real time to help the system coordinate operations of signals and curbs in line with core policy objectives, such as prioritizing safety and transit use
- Informing trip choices by providing real-time information to travellers and mobility services on things like pricing, scheduling, and route closures

To procure this system, the WTMA would publish its technical requirements in detail and survey the market for potential vendors. There are a number of local Canadian and global companies that might respond, including Miovision, Siemens, and GridSmart. If no vendors meet the comprehensive requirements for such a system, Sidewalk Labs would develop one, potentially in partnership with one or more existing companies.

Understanding real-time use.
Cities have started to manage their streets and mobility systems with data-driven tools, from adaptive traffic signals to real-time bus trackers. In Toronto, the King Street pilot program[67] collected information on streetcar delays, car volume, and pedestrian activity to inform new traffic rules that have improved streetcar travel times for 65,000 weekday travellers.

To manage the streets in the neighbourhood well, the mobility management system for the Sidewalk Toronto project would need to be able to gather data on pedestrian and traffic flows as well as transit boarding patterns to understand how all travellers (not just vehicle traffic) are using the transportation system.

This new level of understanding should stretch across all aspects of the transportation system and across all trip modes, from the amount of available space in a loading zone, to the light rail schedule, to the routes of ride-hail vehicles, to the number of pedestrians waiting to cross a street. With a complete portrait of mobility activity, the WTMA would be able to manage the mobility performance in line with its objectives.

Analyzing real-time patterns.

The mobility management system for the Sidewalk Toronto project should use real-time modelling tools to respond to trip patterns, potentially deploying an advanced form of data analysis called “machine learning” to improve those responses over time.

Consider traffic at a typical intersection. The mobility management system would need to know the total number of pedestrians trying to cross, the schedule of light rail vehicles approaching the intersection, and the volume of ride-hail services routed in that direction. Based on that real-time activity, the system’s modelling tools would tell the intersection what to prioritize in line with the WTMA’s policy objectives. In this case, the pedestrian crossing would be prioritized and given the greatest amount of signal time, followed by light rail vehicles, followed by private cars or ride-hail vehicles.

Afterwards, the system would evaluate how it did in that scenario: How many pedestrians got stranded waiting? How much delay time did the light rail experience? How was the travel time of ride-hail vehicles impacted? If the system performed in line with objectives, it would apply the same response to similar scenarios in the future. If something should be tweaked — maybe the crossing signal needs to be held even longer — the system would make that adjustment and learn to improve.

All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the “Digital Innovation” chapter of Volume 2, on Page 374.

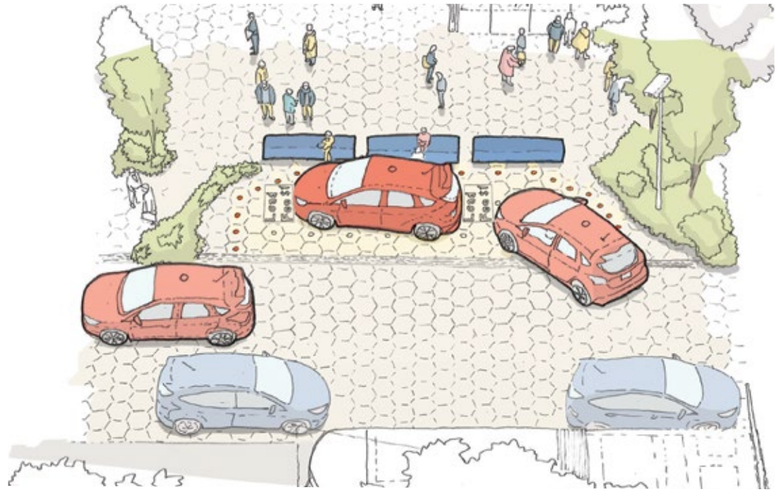
Informing trip choices.

With full knowledge of transportation conditions, a mobility management system would need to provide travellers — and the services they use — with the information needed to make trip choices or adjust travel behaviour. That information might include things like street closures, lane reallocations, public transit arrival times, ride-hail wait times, bike-share availability, or curb prices.
The system would need to provide that information to physical infrastructure, such as traffic signals and pavement, and to digital tools, such as third-party trip apps or ride-hail services.

For example, consider a street that is being closed down on a weekday afternoon for a community gathering. A responsive traffic signal could hold a green cycle longer on the next street over to avoid congestion. Lighted pavement and dynamic signs could be used to indicate that a bike lane is temporarily closed. Ride-hail services could consume information from the system to route vehicles around the closure, and navigation tools could use that information to provide travellers with accurate trip time estimates.

As part of its ability to inform trip choices, the WTMA would build on best practices for demand-based pricing to manage its parking garage and curbside spaces, raising and lowering rates to ensure that spaces are available and used.

In addition to these high-level capabilities, Sidewalk Labs believes there are two core tools that can help enable this coordinated mobility system to flourish: adaptive traffic signals and dynamic curbs.



The dynamic curb (shown here) can be designated as a passenger pick-up or drop-off zone through lighted pavement, then easily converted into pedestrian space during low-traffic periods.

Adaptive traffic signals.

Adaptive traffic signals leverage privacy-preserving sensing and analysis to ensure that intersections are efficiently managing the pedestrians, cyclists, and vehicle traffic in a neighbourhood.

Adaptive traffic signals typically incorporate mounted devices capable of identifying the number, speed, and trajectory of vehicles, pedestrians, and cyclists. Consistent with the proposed approach to responsible data use for the Sidewalk Toronto project, this data would need to be de-identified at the source by default — meaning that any counts or calculations would be processed on the device, deleting any raw footage and retaining only the aggregated numbers for analysis.

Adaptive traffic signals would then optimize signal timing to maximize person throughput at a given intersection, while giving priority to one mode versus another (for example, pedestrians over cars) based on the WTMA’s policy objectives. The signals would communicate their status and imminent timing changes to connected vehicles or self-driving vehicles via short-range communication systems, and would make this data available via API to third-party navigation tools.

Dynamic curb.

The WTMA’s approach to curb management would leverage real-time data and policies set by the WTMA to make the most efficient use of curb space based on actual demand — a concept that Sidewalk Labs calls the “dynamic curb.”

As described earlier (on Page 61), the dynamic curb uses physical infrastructure, such as lighted pavement or signs, to designate available space for passenger pick-ups and drop-offs along streets — including at times when this space is not available to vehicles because it is being repurposed, such as for pop-up street fairs or sidewalk expansions.

The dynamic curb must also publish information about its availability, pricing, and scheduling to third-party trip apps or mobility services, so users can factor this information into their transportation decisions, make reservations, and be alerted to any changes or issues, such as a driver incurring a higher fee for waiting too long at the curb. This ability would reduce the negative impact of curb congestion and double-parking in cities today.

Ch–1

Part 6

Designing People-First Streets

Key Goals

1

Create four new types of streets to move people and make places

Many shortcomings of current city streets stem from a one-size-fits-all approach to their design. A typical downtown street has wide lanes for cars that want to drive at high speeds, and more lanes than necessary to accommodate rush-hour traffic. Curb space is dedicated to parked vehicles or delivery trucks. Cyclists typically ride in close proximity to these faster and larger vehicles. Pedestrians wait for their brief window to cross.

This general pattern leads to discomfort for pedestrians and cyclists at best and to dangerous conflicts at worst.

Rather than designing all streets for all uses at all times, Sidewalk Labs plans to create four street types designed for different speeds and primary uses. Two faster street types (Boulevards and Transitways) would move people and goods through vehicles and public transit and feature separated paths for cyclists and sidewalks for pedestrians. Slower street types (Accessways and Laneways) would provide a safe and comfortable environment for cycling and pedestrian activity.

This people-first street network would serve as a foundation for the mobility options and innovations described in the rest of this chapter to flourish — creating safe, convenient choices for getting around the city without the need to own a car. Sidewalk Labs' streets are also designed to be part of the public realm, with benefits to open space, public health, economic vitality, and social interaction. The network is designed to work on Day One of a neighbourhood like Quayside but reaches transformative potential with safe, reliable self-driving vehicles that can be programmed to follow the rules of the road.

The four street types share some fundamental principles. Each is tailored towards a specific mode. Each prioritizes safety either through speed restrictions or separated lanes. Each incorporates flexibility to make the most of limited street space, enabling quick conversions between transportation and public space purposes. Each reclaims space for pedestrians, buildings, and public uses.

This people-first street network would serve as a foundation for the mobility options and innovations described in the rest of this chapter to flourish.

What makes this approach to street design possible now is a combination of policy innovations, design advances, and new digital tools. These advances enable some key street design changes:

1

Tailor streets for different modes.
Typical streets aim to accommodate all uses at all times, even though each transportation mode is very different in size, top speed, and the vulnerability of the traveller. Harnessing navigation tools, adaptive traffic signals, and other new capabilities, Sidewalk Labs has designed four types of streets — each prioritizing a particular mode.

Laneways prioritize pedestrians. Accessways prioritize cyclists. Transitways prioritize public transit through dedicated lanes and signal priority. Boulevards are intended for all modes but primarily for vehicles.

These streets are narrower overall and tailored to the size and speed of their priority mode, with the goal of improving safety and comfort. This approach is consistent with "complete streets" principles, as space is provided on each street for every mode — except for traditional vehicles driven by people, which are restricted to streets specifically designed for their movement.

Mode-tailored streets become even safer with self-driving vehicles, which can be programmed to pursue the optimal route based on their destination.

2

Separate streets by speed.
On most streets, the difference in speeds among vehicles, cyclists, and pedestrians leads to discomfort or safety hazards. By integrating policy, design practices, and digital tools, Sidewalk Labs can safely separate streets by speed — enabling the network to move people in vehicles while making designated places for pedestrians.

On faster streets that permit vehicles, physical separations can provide comfort and safety for cars, bikes, and pedestrians. Navigation tools can guide faster traffic onto these streets and away from narrower streets meant for slower vehicles and pedestrian street life. Adaptive traffic signals can detect all types of travellers and hold crossing lights to ensure safety.

On slower streets, traditional vehicle access would be restricted; vehicles that must use these streets for accessibility purposes would have to travel at cycling or walking speeds. This approach would advance the principles of "shared streets," which shows that pedestrians, cyclists, and vehicles can coexist safely[68] so long as they are all going the same low speed.

Shared streets would also stand to get safer with self-driving vehicles, which can be programmed to defer to pedestrians and cyclists and to obey speed limits.

3

Incorporate flexibility into street space.
In order to handle rush hour, city streets often have more car lanes than they regularly need. During off-peak periods, these static lanes cannot easily be used for other purposes.

Sidewalk Labs plans to design lanes that are flexible throughout the day, enabling cities to make the most of existing street space. A morning rush-hour car lane could quickly become a bike lane by day and a loading zone by night. Curbside lanes typically devoted to street parking can become dynamic curbs that coordinate pick-ups, drop-offs, and deliveries — adjusting prices for curb access based on congestion.

This flexibility is possible thanks lighted pavement, digital signage, and to the ability to send vehicles information about new lane designations or street closures. Speed separation allows the safe elimination of raised curbs, which enables greater flexibility, allowing for the potential expansion of sidewalk space at off-peak periods.

(Sidewalk Labs also plans to explore better approaches to traditional street designs, such as intersections, using roundabouts instead of traffic lights.)

Flexibility could also improve dramatically with self-driving vehicles, which would automatically know which lanes are closed and would re-route accordingly.

See the "Public Realm" chapter of Volume 2, on Page 118, for more details on reclaiming pedestrian space.

4

Recapture street space for other uses.
By designing streets around shared mobility fleets instead of private car ownership, Sidewalk Labs can recapture curbside parking for wider sidewalks, new bike lanes, and passenger and freight loading zones. This design change is further made possible because expanded transit service and cycling options leads to fewer overall car trips. Remote parking facilities mean that remaining private cars can park off the street.

As self-driving vehicles become widely available, streets can recapture even more space through narrower lanes, since these vehicles can be programmed to stay reliably in the centre of lanes without veering.

All told, these designs can help capture at least 91 percent more pedestrian open space on major boulevards.

Goal 1

Designing
People-First Streets

Create four new types of streets to move people and make places

Based on these principles, Sidewalk Labs has designed four street types that together create a complete mobility network that balances the need to get people places with the needs for pedestrian safety and street life.

This network would be the first to be designed by leveraging the eventual capabilities of self-driving vehicles, with the knowledge that this technology must be thoughtfully integrated into future cities to improve — and not undermine — urban mobility.

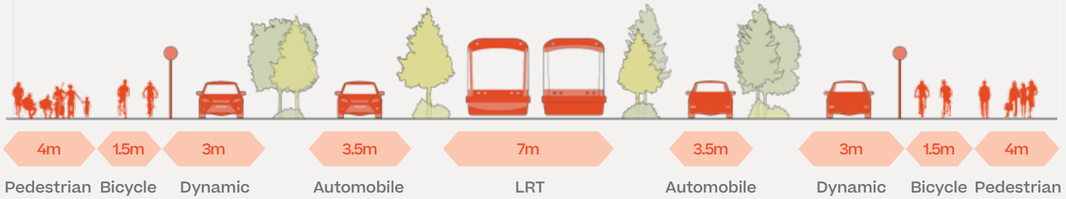
These street types are designed to operate safely and effectively in existing cities with traditional vehicles but reach their peak potential in a world of self-driving vehicles that can be programmed to follow traffic rules, rerouted by a mobility management system, programmed to defer to pedestrians.

These street types are: Boulevards, Transitways, Accessways, and Laneways.

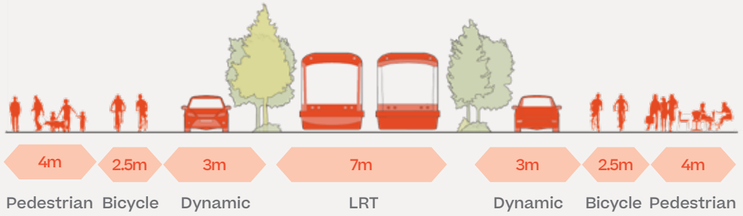
This network would be the first to be designed by leveraging the capabilities of self-driving vehicles.

Street type section views

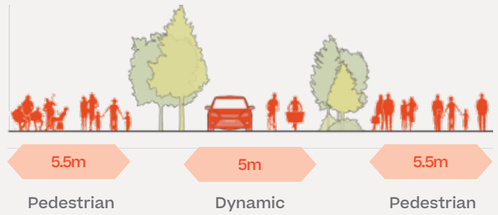
Together these streets can be combined to create a complete mobility network.



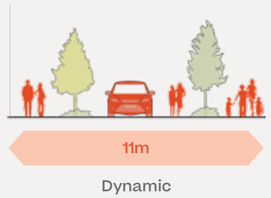
Boulevard: 31 metres
Priority mode: All modes
Priority speed: 40 km/h
Boulevards are designed primarily to accommodate longer-distance car trips and faster traffic. In the IDEA District, they could account for 10 percent of the total road network length.



Transitway: 26 metres
Priority mode: Public transit
Priority speed: 40 km/h
Transitways are designed to prioritize public transportation in designated lanes. In the IDEA District, they could make up roughly 6 percent of the total street network length.



Accessway: 16 metres
Priority mode: Cyclists
Priority speed: 22 km/h
Accessways are designed primarily for cyclists, with traffic moving at bike speeds. In the IDEA District, they could make up a third of all street types.



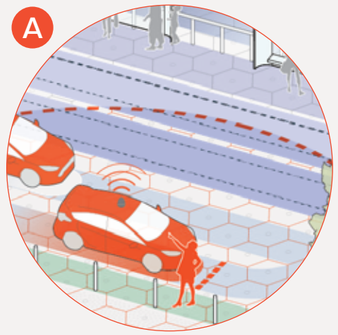
Laneway: 11 metres
Priority mode: Pedestrians
Priority speed: 8 km/h
Laneways form the foundation of the pedestrian network. In the IDEA District, they would be the most common street type.

Street Type 1

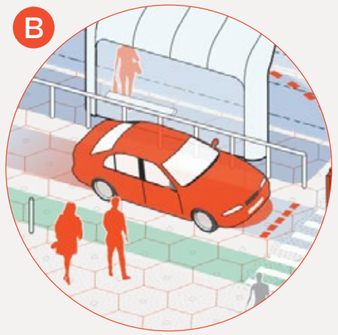
Boulevard

31 metres

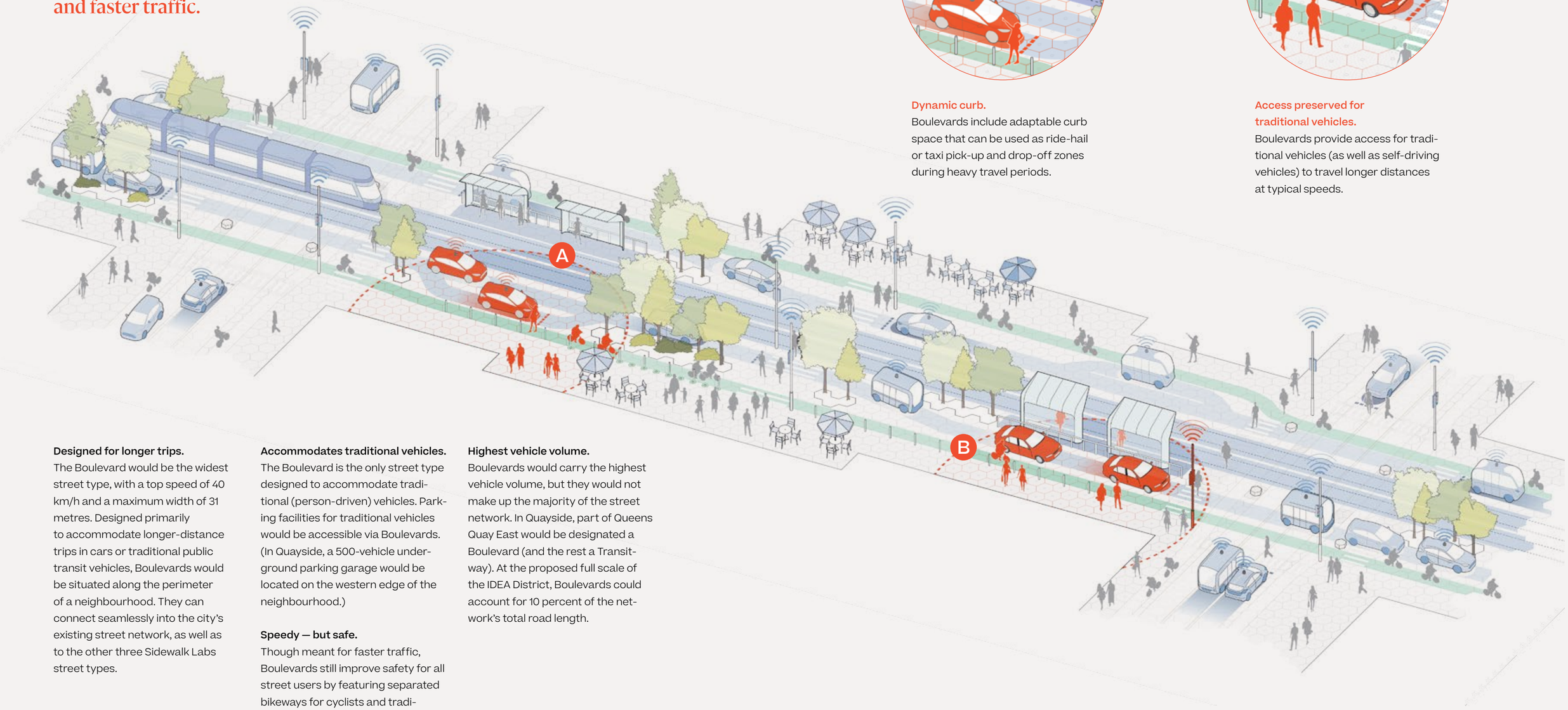
Boulevards are designed primarily to accommodate longer-distance car trips and faster traffic.



Dynamic curb.
Boulevards include adaptable curb space that can be used as ride-hail or taxi pick-up and drop-off zones during heavy travel periods.



Access preserved for traditional vehicles.
Boulevards provide access for traditional vehicles (as well as self-driving vehicles) to travel longer distances at typical speeds.



Designed for longer trips.
The Boulevard would be the widest street type, with a top speed of 40 km/h and a maximum width of 31 metres. Designed primarily to accommodate longer-distance trips in cars or traditional public transit vehicles, Boulevards would be situated along the perimeter of a neighbourhood. They can connect seamlessly into the city's existing street network, as well as to the other three Sidewalk Labs street types.

Accommodates traditional vehicles.
The Boulevard is the only street type designed to accommodate traditional (person-driven) vehicles. Parking facilities for traditional vehicles would be accessible via Boulevards. (In Quayside, a 500-vehicle underground parking garage would be located on the western edge of the neighbourhood.)

Speedy — but safe.
Though meant for faster traffic, Boulevards still improve safety for all street users by featuring separated bikeways for cyclists and traditional (though curbless) sidewalks for pedestrians. At intersections, responsive traffic signals can detect safety risks and adjust lights to protect pedestrians accordingly.

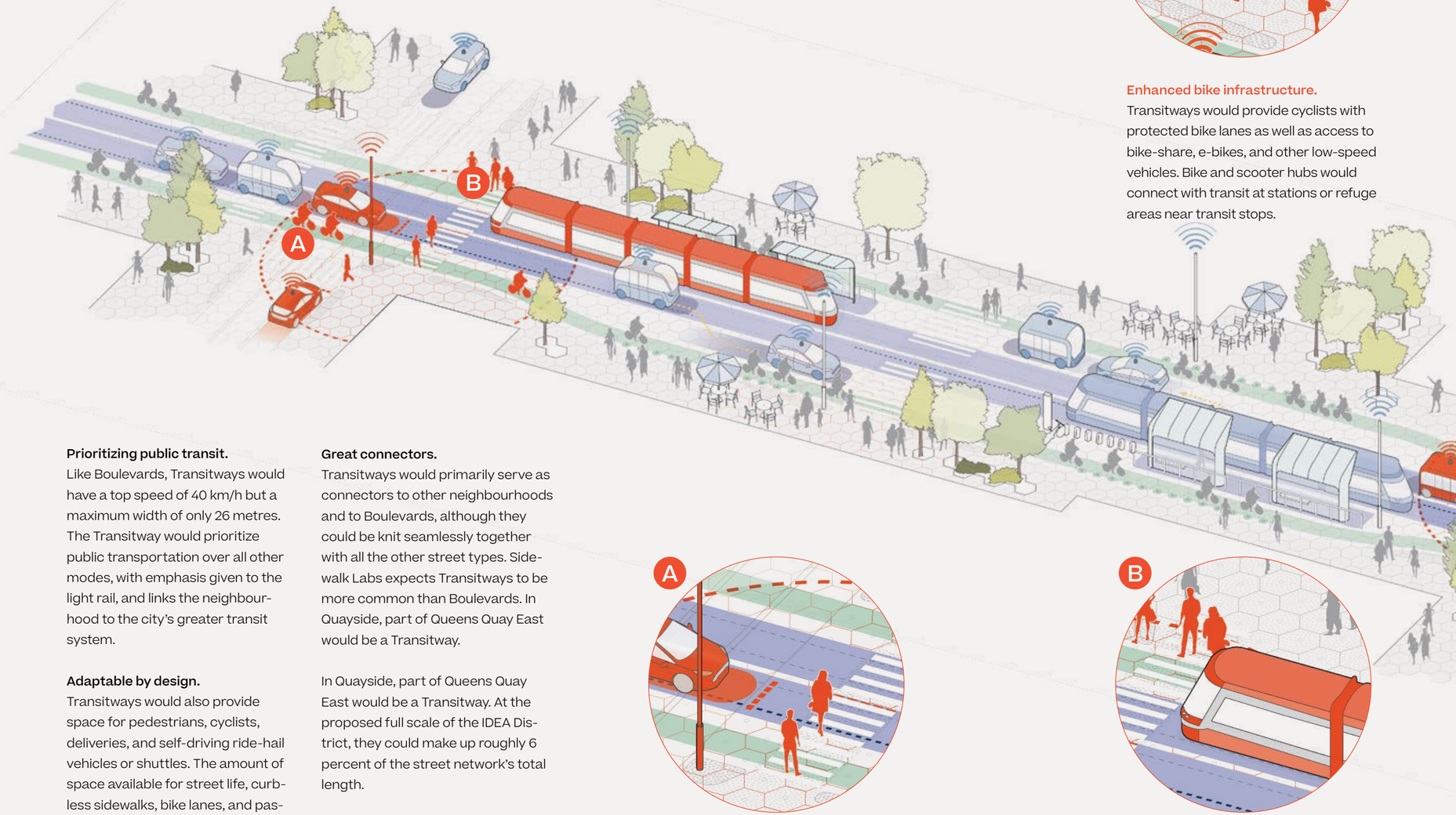
Highest vehicle volume.
Boulevards would carry the highest vehicle volume, but they would not make up the majority of the street network. In Quayside, part of Queens Quay East would be designated a Boulevard (and the rest a Transitway). At the proposed full scale of the IDEA District, Boulevards could account for 10 percent of the network's total road length.

Street Type 2

Transitway

26 metres

Transitways are designed to prioritize public transportation in designated lanes.



Prioritizing public transit.
Like Boulevards, Transitways would have a top speed of 40 km/h but a maximum width of only 26 metres. The Transitway would prioritize public transportation over all other modes, with emphasis given to the light rail, and links the neighbourhood to the city's greater transit system.

Adaptable by design.
Transitways would also provide space for pedestrians, cyclists, deliveries, and self-driving ride-hail vehicles or shuttles. The amount of space available for street life, curbless sidewalks, bike lanes, and passenger loading zones can contract or expand based on demand thanks to dynamic curbs. These changes could be communicated to travellers through digital signage, navigation tools, or lighted pavement.

Great connectors.
Transitways would primarily serve as connectors to other neighbourhoods and to Boulevards, although they could be knit seamlessly together with all the other street types. Sidewalk Labs expects Transitways to be more common than Boulevards. In Quayside, part of Queens Quay East would be a Transitway.

In Quayside, part of Queens Quay East would be a Transitway. At the proposed full scale of the IDEA District, they could make up roughly 6 percent of the street network's total length.

Shorter, safer crosswalks.
Adaptive traffic signals can prioritize pedestrians at crossings that are now shorter due to narrower roadways and wider sidewalks.

Transit priority.
Public transportation vehicles would get priority on Transitways through adaptive traffic signals that give them the green light and lanes where self-driving vehicles can pull off to let transit vehicles pass. A two-stage crossing that uses dynamic pavement technology would allow pedestrians to cross unimpeded when the light rail is not present and would pause pedestrians in a refuge area when the light rail has received priority.

Enhanced bike infrastructure.
Transitways would provide cyclists with protected bike lanes as well as access to bike-share, e-bikes, and other low-speed vehicles. Bike and scooter hubs would connect with transit at stations or refuge areas near transit stops.

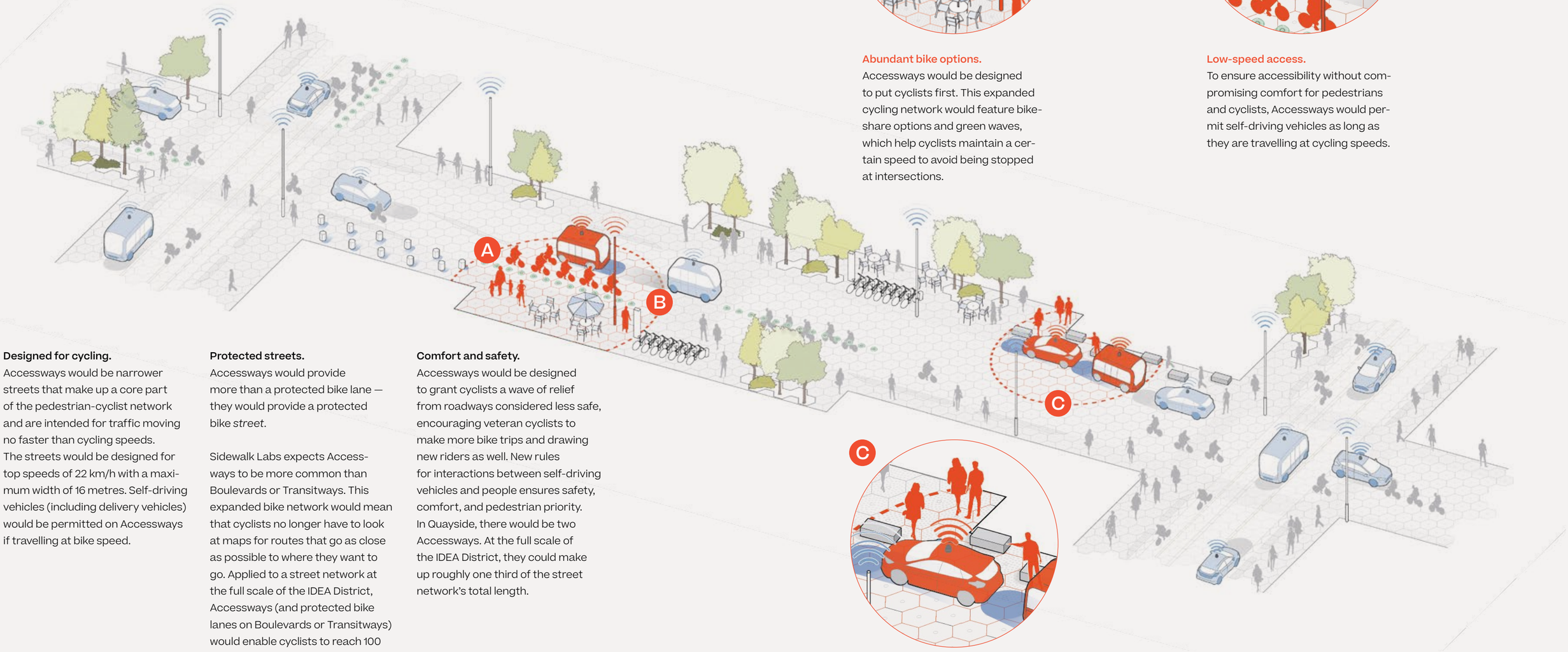
Wider sidewalks.
By eliminating street parking, Transitways (and all streets) would recapture this space for other purposes, including wider sidewalks.

Street Type 3

Accessway

16 metres

Accessways are designed primarily for cyclists, with traffic moving at bike speeds.



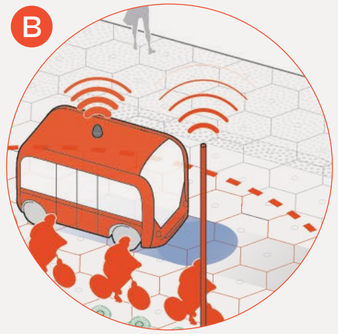
Designed for cycling.
Accessways would be narrower streets that make up a core part of the pedestrian-cyclist network and are intended for traffic moving no faster than cycling speeds. The streets would be designed for top speeds of 22 km/h with a maximum width of 16 metres. Self-driving vehicles (including delivery vehicles) would be permitted on Accessways if travelling at bike speed.

Protected streets.
Accessways would provide more than a protected bike lane — they would provide a protected bike *street*.

Sidewalk Labs expects Accessways to be more common than Boulevards or Transitways. This expanded bike network would mean that cyclists no longer have to look at maps for routes that go as close as possible to where they want to go. Applied to a street network at the full scale of the IDEA District, Accessways (and protected bike lanes on Boulevards or Transitways) would enable cyclists to reach 100 percent of buildings on a dedicated bike lane or roadway designed for bikes. Accessways would not have separated sidewalks, instead guiding cyclists and pedestrians via lighted pavement or digital signs.

Comfort and safety.
Accessways would be designed to grant cyclists a wave of relief from roadways considered less safe, encouraging veteran cyclists to make more bike trips and drawing new riders as well. New rules for interactions between self-driving vehicles and people ensures safety, comfort, and pedestrian priority. In Quayside, there would be two Accessways. At the full scale of the IDEA District, they could make up roughly one third of the street network's total length.

Abundant bike options.
Accessways would be designed to put cyclists first. This expanded cycling network would feature bike-share options and green waves, which help cyclists maintain a certain speed to avoid being stopped at intersections.



Low-speed access.
To ensure accessibility without compromising comfort for pedestrians and cyclists, Accessways would permit self-driving vehicles as long as they are travelling at cycling speeds.

Reinforcing safety.
Movable street furniture can be used to reinforce safe site zones in a mixed curbless environment.

Street Type 4

Laneway

11 metres

Laneways form the foundation of the pedestrian network. In the IDEA District, they would be the most common street type.

Designed for walking.
Laneways would form the foundation of the pedestrian network and would be the most common type of street.

These streets would be designed for pedestrian speeds, with a top speed of 8 km/h and a maximum width of 11 metres. Bikes and low-speed, self-driving vehicles for people with accessibility needs would be permitted on laneways if travelling at the proper speed.

Streets as places.
Laneways would help people get places, but also to be places unto themselves, filled with pop-up shops, street fairs, and other types of community gatherings.

All space on the Laneway would be shared. Heated pavement would create a welcoming pedestrian atmosphere year-round, and moveable street furniture would encourage a vibrant and ever-changing streetscape.

The most common street type.
In Quayside, there would be one Laneway. At the full scale of the IDEA District, Laneways and pedways could make up roughly half of the street network's total length.

Maintaining pedestrian speeds.
Street furniture and landscaping design would encourage cyclists to walk bikes especially when streets are filled with pedestrians.

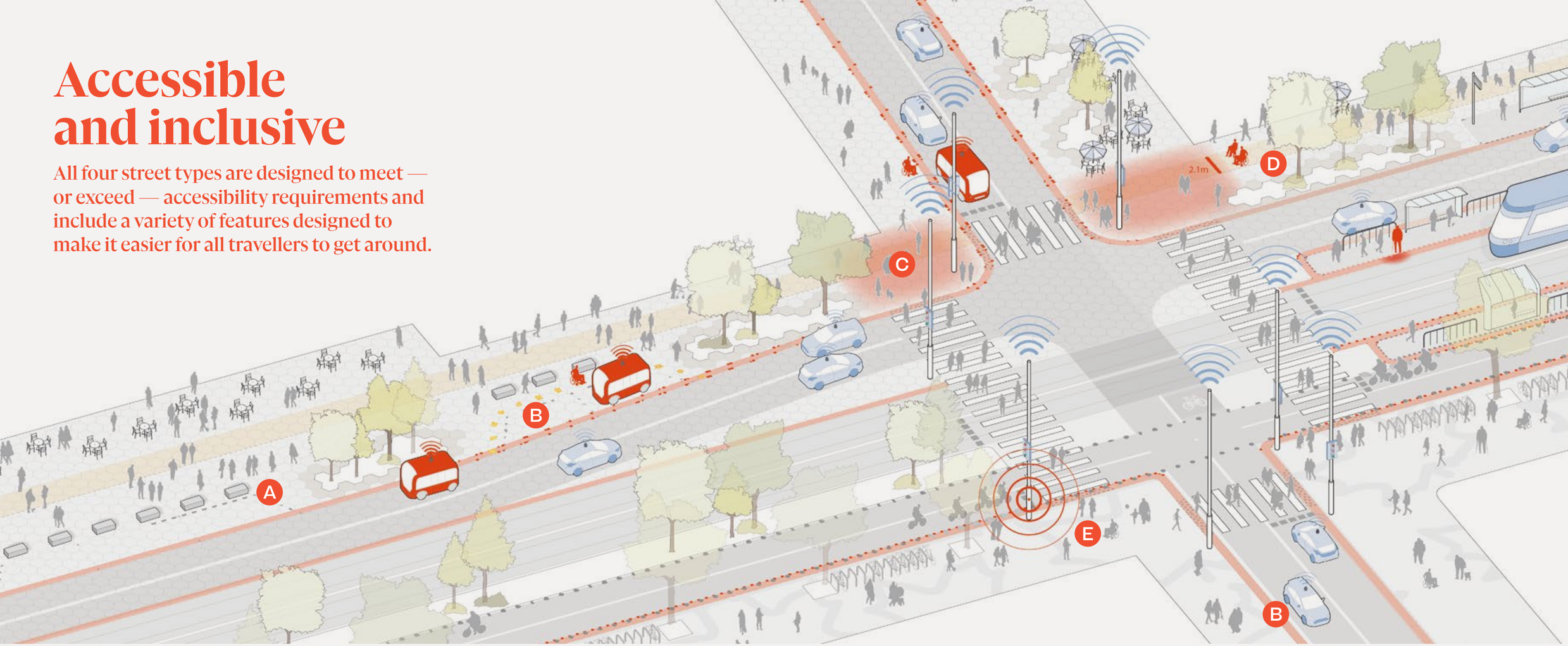
Active street life.
A suite of street amenities, such as heated pavement and movable furniture, would help people use Laneways for shops, gatherings, fairs, and other lively uses.

Pedestrian priority.
Laneways enable pedestrians to rule the streets, since most vehicles would prefer to travel on Boulevards and Transitways and self-driving vehicles could be routed there by real-time navigation systems. Vehicles travelling at pedestrian speeds can still use Laneways to ensure accessibility for the elderly, people in wheelchairs, or others who need it.

Pedways.
A subset of Laneways — pedestrian-only pedways — would not allow any vehicle traffic at all, adding yet another dimension to the walking network.

Accessible and inclusive

All four street types are designed to meet — or exceed — accessibility requirements and include a variety of features designed to make it easier for all travellers to get around.



Travelling freely and safely at street level is a cornerstone of an accessible city. With this goal in mind, Sidewalk Labs would design streets that put people first, including those using wheelchairs and other mobility devices, those travelling with service animals, and those with varying levels of sensory perception and attention. Every street would be designed to meet all the requirements of the 2005 Accessibility for Ontarians with Disabilities Act (AODA), including low-to-no curbs, textured pavement at pick-up and drop-off points, and pedestrian crossing controls. Wherever possible, Sidewalk Labs would aim to exceed these requirements. Emergency vehicles would be able to access every building, in accordance with the City of Toronto's Roadway Design Considerations Summary Memo. The aim is to be fully accessible across all aspects of daily life.

A Curbless streets.
In Quayside, instead of a vertical step separating the vehicle right-of-way from pedestrian paths, tactile indicators will indicate the line between pedestrian-only areas and spaces shared between pedestrians, bikes, and low-speed vehicles.

B Accessible vehicles.
Self-driving vehicles promise a revolution in personal mobility, with particular benefits for people experiencing different levels of mobility and sensory perception. Sidewalk Labs plans to strongly promote end-to-end accessibility for self-driving and ride-hailing vehicle services.

C Modular heated pavement.
Sidewalk and road maintenance can be a common impediment to accessibility. In Quayside, pavers would be modular, meaning that if one cracks or breaks, it can be quickly replaced. Pavers at key street crossings and intersections would include heating elements that can help to prevent snow and ice buildup on pedestrian throughways. Heated pavers coupled with building awnings that protect from rain and snow would make streets more passable for people using wheeled mobility devices and more comfortable for service animals year-round.

D Sidewalk width.
All thoroughfares in Quayside would have at least enough room for two people using mobility devices (such as wheelchairs, scooters, and white canes) to ride or travel side by side in each direction, or for two people to sign while walking. Even more room will be provided wherever possible.

E Wayfinding beacons.
Wayfinding beacons can broadcast information about the environment to people who are blind or partially sighted to help them navigate the area. In Quayside, beacons would enable the use of BlindSquare and other wayfinding apps as part of the default street-level experience.

Ch–1

Public Engagement

The following summary describes feedback related to **mobility** and how Sidewalk Labs has responded in its proposed plans.

As part of its public engagement process, members of Sidewalk Labs' planning and innovation teams talked to thousands of Torontonians — including members of the public, expert advisors, civic organizations, and local leaders — about their thoughts, ideas, and needs across a number of topics.

1 Put pedestrians and cyclists first

What we heard

From the very beginning of Sidewalk Labs' public engagement process, one mobility note kept coming up time and again across workshops, advisory working groups, and special reports: prioritize pedestrians and cyclists. Safety and the management of conflicts among road users were top of mind. As one roundtable participant put it: "Greater access to pedestrian laneways and safer bike lanes would make me more likely to even bike — and not think I may turn into roadkill!"

The Mobility Advisory Working Group pushed Sidewalk Labs to innovate when it came to road design, speed limits, and curb space, stressing the need to consider the unpredictability of shared streets; where and how pedestrians cross the street; and cycling infrastructure (for bikes as well as e-bikes and scooters) that is accessible in all conditions. The Sidewalk Toronto Fellows similarly advocated for safe, all-weather active transportation.

Participants at Roundtable 4 supported the decision to restrict vehicles, especially in Parliament Plaza, and were enthusiastic about water transportation modes, such as kayaks. Roundtable participants, as well as participants in co-design sessions pushed Sidewalk Labs to meet and surpass AODA compliance when designing for pedestrians and cyclists.

307 is home to the very first Bike Share Toronto station in Quayside. Credit: David Pike

How we responded

Designing people-first streets.
Sidewalk Labs proposes a people-first street network designed to enhance safety, comfort, and street life for pedestrians and cyclists. Lower-speed streets would require vehicles to travel at pedestrian or cyclist speeds, and boulevards that permit higher-speed traffic (up to 40 km/h) would contain dedicated bike lanes with physical separations (see Page 92).

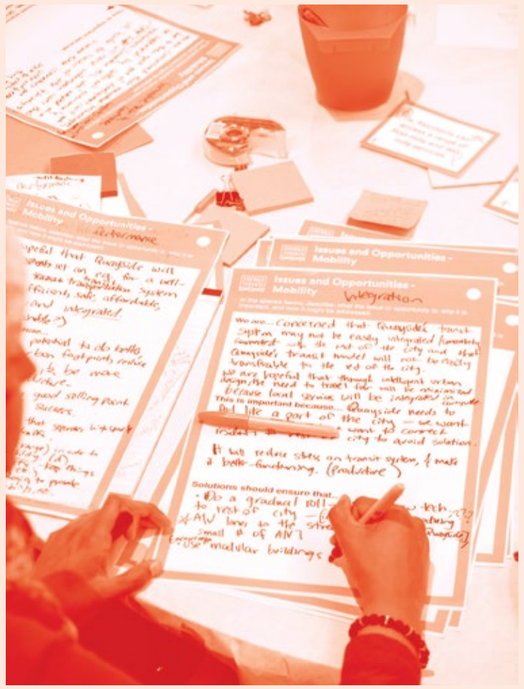
Providing mobility choices.
Sidewalk Labs proposes a cost-effective, integrated mobility package that makes cycling and walking easier and more convenient. For example, a monthly subscription could cover a discounted TTC pass, an unlimited Bike Share Toronto membership, access to e-scooters and other low-speed vehicles, and credits for rides with ride-hail or car-share providers (see Page 65).

Improving bike infrastructure.
Sidewalk Labs proposes to include bicycle "green waves," which use signal coordination to help cyclists maintaining a certain speed avoid stopping at red lights, improving travel time and increase safety (see Page 49).

Creating all-weather infrastructure.
Sidewalk Labs proposes heated pavement in sidewalks and bike lanes, as well as an outdoor comfort system to shield pedestrians and cyclists from wind, rain, ice, and snow (see Page 52).

Planning walkable neighbourhoods.
Sidewalk Labs proposes a truly walkable neighbourhood, where residents and workers can access jobs, homes, and daily goods or services within a 15-minute walk (see Page 44).

Ensuring accessibility.
Sidewalk Labs commits to physical and digital accessibility principles that require streets to be accessible for people of varying abilities. This plan would include curbless streets with sidewalks wide enough to accommodate pedestrians moving side by side in wheeled devices or walking and signing; consistent visual, auditory, and tactile cues to guide people through spaces; and special vehicle permissions for accessible ride-hail vehicles (see Page 106).



A member of the public provides feedback on mobility "issues and opportunities" during a Sidewalk Toronto Public Roundtable. Credit: David Pike

2 Improve transit, expand it, and make it inclusive

What we heard

Participants expressed frustration with the current transportation system, particularly traffic congestion, and excitement about the opportunity to rethink mobility in Toronto.

Torontonians felt strongly that public transit must be a central focus of any mobility plan, especially if the project aims to reduce levels of private vehicle ownership, and that the transit experience in Quayside must be efficient and easy to use. As one roundtable participant explained: "Personally, if transit were more accessible and affordable, I would use my car less."

The inclusivity of transit was also a key theme. The Mobility Advisory Working Group and the Sidewalk Toronto Residents Reference Panel encouraged the Sidewalk Labs mobility team to apply a user-experience lens to its plan, while co-design participants emphasized design and signage that would be accessible across visual, auditory, and cognitive abilities.

But public transit cannot be efficient, convenient, or inclusive if it is isolated from Toronto's greater systems. The Mobility Advisory Working Group encouraged Sidewalk Labs to build on the city's existing plans and research. This need to integrate public transit in Quayside into city and regional transit — and to plan in step with the city — was particularly important to Roundtable 4 participants and to those on the Residents Reference Panel.

How we responded

Expanding transit.
Sidewalk Labs proposes connecting Quayside with Toronto's existing transit system before any residents move in and accelerating the financing of a light rail expansion that builds on the extensions identified as critical by existing planning initiatives, such as the Port Lands Planning Framework and Waterfront Toronto's Transit Reset efforts (see Page 40).

Designing transit-friendly streets.
Sidewalk Labs proposes street designs with speed limits that encourage pedestrian travel, electric bikes, and other low-speed vehicles as attractive commuting options, improving last-mile connections and making public transit more attractive (see Page 92).

Offering integrated mobility options.
Sidewalk Labs proposes an integrated mobility package that would give residents and workers a real-time understanding of the real price of each transportation option, encouraging the choice of public transit via discounts and credits (see Page 65).

Ensuring accessibility.
The TTC's stated policy is to create step-free transit stops for streetcars and buses, and to provide the most updated, accessible vehicles available at present to serve Quayside. Sidewalk Labs plans to collaborate with city transit partners and commit to ensuring this reality (see Page 106).

Coordinating bus service.
Sidewalk Labs plans to ensure that bus service is well-integrated into other modes, making it easier and more convenient for riders to transfer across mobility options (see Page 45).

3 Be ambitious — but allow for transition

What we heard

"We've been designing roads the same way for 100 years. Maybe it's time to rethink how we do that, so that roads are more responsive and fluid," said one of the Reference Panel residents. Other engagement participants agreed. At Roundtable 3, when Sidewalk Labs presented five types of potential Quayside streets, Torontonians pushed for ambition in the plan's mobility aspirations.

At the same time, participants noted that any new technology must be introduced carefully. On this topic, no subject generated more excitement — and concern — than self-driving vehicles.

Roundtable participants and the Mobility Advisory Working Group were vocal about the potential upsides of this technology. The Advisory Working Group was not only intrigued by the ability of self-driving fleets to reclaim street space typically devoted to curbside parking, but they also saw self-driving vehicles as an exciting solution to the challenge of first- and last-mile trips — for people as well as for the delivery of goods.

Many Torontonians also expressed concern with the cost, safety, and accessibility of self-driving vehicles, as well as their relationship with public transit.

Both the Mobility Advisory Working Group and the Residents Reference Panel emphasized the need to learn from leading experts; to take time to transition to self-driving vehicles; and to ensure that alternative transportation options are available, the public is educated, and proper regulation is in place. Reference Panel and Roundtable 4 participants cautioned that some parking and vehicle access in Quayside could be necessary to prevent the community's isolation from the GTA and to allow for TTC WheelTrans (an accessible paratransit service in Toronto) and emergency vehicles.

How we responded

Designing streets for the future.
Sidewalk Labs proposes streets that anticipate self-driving vehicles but that can also be successful without them. The streets in Quayside can easily adapt to "make room" for these vehicles as they become more commonplace (see Page 96).

Providing occasional car access.
Sidewalk Labs proposes to provide access to a variety of on-site car-sharing and car-rental providers, helping residents make the occasional car trip while relying less on traditional private vehicle ownership (see Page 63).

Ensuring accessibility.
Sidewalk Labs proposes special permissions so accessible ride-hail, WheelTrans, and emergency vehicles can access any street (see Page 106).

Offering parking.
Sidewalk Labs' plans include an underground on-site parking garage offering 500 spaces to private vehicles using demand-based pricing. The plan also would include off-site parking facilities that feature charging stations to encourage use of electric vehicles (see Page 64).

Working with regulatory experts.
Sidewalk Labs has collaborated with MaRS, one of the world's largest urban innovation hubs, and is working with various branches of the Canadian government to determine a regulatory framework for self-driving vehicles that would ensure public safety. Sidewalk Labs is also pursuing future pilots that would incorporate a public focus (see Page 55).

4 Infrastructure and transportation systems that stand the test of time

What we heard

The importance of infrastructure, and the importance of maintaining aging infrastructure in particular, came up frequently in public engagement events.

Participants of Roundtable 4 wanted to know more about the nature of the funding and governance models for Quayside's infrastructure, and the Mobility Advisory Working Group stressed the importance of plans that are financially feasible over the long term. While the group supported a private-public mobility governance model — provided jurisdiction is clear — they also cautioned Sidewalk Labs to be practical about what the city could provide in terms of infrastructure development and maintenance. Roundtable 4 participants similarly echoed this governance concern, particularly in relation to extending the light rail system and working with the TTC. The Mobility Advisory Working Group also recommended that any mobility management system oversee both design and operations.

How we responded

Financing responsibly.
To pay for some of the significant transportation infrastructure needs of Quayside, including the expansion of the light rail and upgrades to the Parliament Street and Cherry Street underpasses, Sidewalk Labs proposes a self-financing system that pays for part of the costs of construction by borrowing capital against funds generated by a future tax on real estate development (see Page 40).

Working with the TTC.
Sidewalk Labs proposes that light rail infrastructure, vehicles, and service remain publicly owned and operated by the TTC, and that a non-profit or government entity manage funds and transfer them to the TTC (see Page 40).

Using parking fees for maintenance.
Sidewalk Labs proposes that demand-based parking fees contribute to the maintenance of infrastructure (see Page 86).

Proposing holistic transportation management.
In accordance with the recommendation that a mobility management system oversee design and operations in Quayside, Sidewalk Labs proposes that a public entity called the Waterfront Transportation Management Association coordinate the transportation system (see Page 86).

Torontonians explore the 307 main hall exhibits — including the modular pavement demonstration — during the first Open Sidewalk, on June 16, 2018. Credit: David Pike

Engagement spotlight

The Sidewalk Toronto Fellows suggested that the project use the type of bike path foot rests they found during a research trip to Copenhagen, Denmark. Credit: Sidewalk Labs

When the Sidewalk Toronto Fellows presented their findings at the end of 2018, Sidewalk Labs Director for Streets Willa Ng was in the audience, paying close attention. As the Fellows discussed their many takeaways from their travels around the world, they began talking about Amsterdam and Copenhagen, cities that make cycling not only safe, but easy and delightful. They showed one small example: a foot railing that cyclists could rest upon at red lights.

The idea of having foot railing had also come up a few weeks before, at a project design jam focused on the theme of "People on Wheels." Willa had heard that feedback, too.

"It's so beautiful in its simplicity," she says. "It just goes to show that ideas don't always have to be technological — innovation comes in a lot of forms." Sidewalk Labs intends to include foot railings in future street designs, and these simple amenities will hopefully be a daily reminder that, in Quayside, cyclists and pedestrians come first.

By providing a broad menu of affordable options for every trip, this comprehensive plan reduces the need to own a car and sets a bold new course for urban mobility.

Acknowledgements

Sidewalk Labs would like to extend special thanks to the participants of the Sidewalk Toronto Mobility Advisory Working Group, and to the staffs of the City of Toronto, Province of Ontario, and Government of Canada for their time and guidance.

Endnotes

General note: Unless otherwise noted, all calculations that refer to the full proposed IDEA District scale are inclusive of the entirety of its proposed geography, including all currently privately held parcels (such as Keating West). Unless otherwise noted, all currency figures are in Canadian dollars.

Charts note: Sources for the charts and figures in this chapter can be found in the accompanying copy for a given section; otherwise, the numbers reflect a Sidewalk Labs internal analysis. Additional information can be found in the MIDP Technical Appendix documents, available at www.sidewalktoronto.ca/midp-appendix.

1. Benjamin Dachis, *Cars, Congestion and Costs: A New Approach to Evaluating Government Infrastructure Investment*. Toronto: C.D. Howe Institute, 2013. 2.
2. This $10,000 figure includes the annual cost of financing, insurance, registration, fuel, parking, and maintenance and repair. See the "New Mobility" section of the MIDP Technical Appendix for a detailed breakdown.
3. Statistics Canada, "Journey to work: Key results from the 2016 Census." *The Daily*, November 29, 2017. Table 2.
4. University of Toronto, Department of Civil Engineering, Data Management Group, "TTS 2016 City of Toronto summary by ward." *2016 Transportation Tomorrow Survey,* 2017. 14-15.
5. Data Management Group, "TTS 2016 Toronto summary by ward," 33-35, 42-43.
6. This projection is based upon the best available current data regarding the development, performance, and adoption of self-driving technologies. See the "New Mobility" section of the MIDP Technical Appendix for details.
7. Ben Spurr, "The TTC needs $33.5 billion to keep the system functional — roughly two-thirds of which are unfunded, report says." *The Toronto Star*, January 18, 2019.
8. Hatch Consulting, *Economic Impact Study: Acceleration of the Implementation of Toronto Waterfront East LRT.* Prepared for the Toronto Waterfront BIA, January 2019. 16.
9. For more information on the proposed additional LRT segments and the total cost of the expansion, see the "Enabling Rapid Transit" section of the MIDP Technical Appendix.
10. Hatch, *Waterfront East LRT*, 29.
11. See the "Enabling Rapid Transit" section of the MIDP Technical Appendix for more information on ridership projections.
12. David L.A. Gordon, *The crash and rebound of Canary Wharf.* Philadelphia: Samuel Zell & Robert Lurie Real Estate Center, Wharton School, University of Pennsylvania, 2001. 78-79.
13. Chittaranjan Tembhekar, "Work on 5 Mumabi Metro lines to start in December." *The Times of India*, May 8, 2017.
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15. Elizabeth Church, "Integrated TTC-GO fare urged for Liberty Village riders." *The Globe and Mail*, October 23, 2013.
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17. City of Calgary. *Rivers District Community Revitalization Plan*. April 2007. 73.
18. City of Toronto, *Implementation of the SmartTrack Stations Program and the Metrolinx Regional Express Rail Program*. Report to Executive Committee. April 10, 2018.
19. Hatch, *Waterfront East LRT*, 31.
20. For more information on ridership and job-accessibility projections, consult the "Enabling Rapid Transit" section of the MIDP Technical Appendix.
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Chapter 2

Public Realm

Ch–2

Introduction

The Vision

A system of **streets, parks, plazas,** and **open spaces** that **encourages people to spend more time outdoors,** together.

An expansive open space network is vital to creating a neighbourhood culture and forming community bonds. That is a big reason why the United Nations has embraced "access to safe, inclusive and accessible" open spaces as part of its Sustainable Development Goals and why Toronto has been developing a new open space plan for downtown.

Decades of research have substantiated the tie between urban nature and well-being, and yet only 40 percent of Canadians say they get outside every day.[1] Time spent inside is increasingly spent alone; solo living is by far the most common household type in Toronto.[2] Loneliness has become such a public health problem that it is comparable to smoking as a risk factor for illness.[3]

This growing sense of urban isolation threatens the social fabric of vibrant neighbourhoods. Research from the Center for Active Design has found that more responsive programming,

operations, and maintenance can increase neighbourhood interactions by 10 percent and community pride by as much as 15 percent.[4] An "everyday" public realm is not meant to be an escape from the city, but instead to be a fundamental shaper of the community — filled with civic engagement, exploration, and connections to people and place.

Sidewalk Labs believes that plentiful, accessible, and exciting public space filled with people all day and all year is a fundamental element of urban life, not an exclusive amenity. This approach to the public realm incorporates new design practices and emerging digital tools to provide more open space, to activate that space more of the time, and to enable it to be more responsive to the community. This three-part strategy aims to help people spend more time outdoors, together.

The innovation plan.

First, Sidewalk Labs plans to deliver more space. Increased walking, cycling, and transit options — coupled with ride-hail services and eventually self-driving vehicles — create an opportunity to reclaim street space for the public realm. This expansion of open space not only enables more public activity but also creates more room for green landscaping and urban nature. To make the most of this space, Sidewalk Labs plans to design flexibility into parks and plazas and to use a digital planning and evaluation tool that can help maximize access to open space while preserving the dense downtown development that creates housing and jobs.

Second, Sidewalk Labs plans to enable open space to be activated more of the time. Adaptable ground-floor spaces could evolve throughout the days, seasons, or years and accommodate a much wider variety of uses than conventional developments — from traditional retail, to social or community initiatives, to production work. A digital leasing and operations system would enable easier set-up for short-term pop-ups and co-tenancy arrangements among businesses with diverse operating hours. A carefully engineered outdoor comfort system could respond to real-time weather patterns to provide shade on sunny days and protection on rainy or snowy ones.

Finally, Sidewalk Labs plans to make space more responsive to the needs of the community. Shared physical infrastructure (such as communal access to projectors or power) would empower the community to program public spaces, making it easy to stage events, such as art installations or local gatherings. A real-time map of park assets — from drinking fountains to garbage bins to utility pipes — would help managers operate and maintain these spaces in ways that keep them active and detect infrastructure issues early.

The impact.

In a neighbourhood the size of Quayside, these initiatives would lead to streets with up to 91 percent more pedestrian space and nearly twice the number of trees; ground-floor space that is activated for 33 percent more time each day; and outdoor spaces that are comfortable for 35 percent more hours throughout the year — all compared with conventional development.[5] The expanded availability of the public realm, activated by commu-

nity-driven programs and better maintenance, would create shared spaces that encourage exploration and provide new opportunities for small business.

In Quayside, Sidewalk Labs proposes that the administration of these innovations be handled by a new non-profit entity called the Open Space Alliance that would bring together government, residents, landowners, and tenants.

The proposed Open Space Alliance is detailed on Page 178 of this chapter and in Volume 3.

Deployed at the full scale of the IDEA District, this holistic approach would result in a seamless network of spaces unlike any in the world. Sidewalk Labs estimates that the IDEA District could become home to more open space than previously planned, with a greater variety of spaces and double the number of comfortable outdoor hours for key spaces. People would be able to comfortably walk for kilometres through lively streets that open onto intimate plazas full of busy cafés, passing through an array of parks that weave together rolling gardens with renewed post-industrial structures. That variety of uses would draw ever more people into the public realm, which would act as the backbone of local civic life and a backyard for families.

Additionally, as jobs are increasingly attracted to dense neighbourhoods, a diverse network of open spaces would be a key driver for fostering economic growth and opportunity. Flexible, affordable ground-floor spaces could support the growth of urban production and become both community incubators and regional attractions.

A great public realm should serve as the foundation of a great community, where people spend more of their time outdoors, together — improving health and happiness and strengthening social ties.

Benefits of implementing the vision

- Nearly twice the number of sidewalk trees as on typical boulevards
- A community empowered to program its public spaces
- New opportunities for small businesses through flexible ground floors
- Outdoor spaces that are comfortable year-round

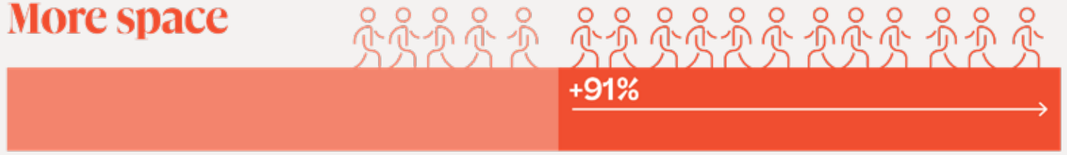
IDEA District

The 77-hectare Innovative Design and Economic Acceleration (IDEA) District, consisting of Quayside and the River District, provides sufficient geographic scale for innovations to maximize quality-of-life impact and to become financially viable.

More time outdoors, together

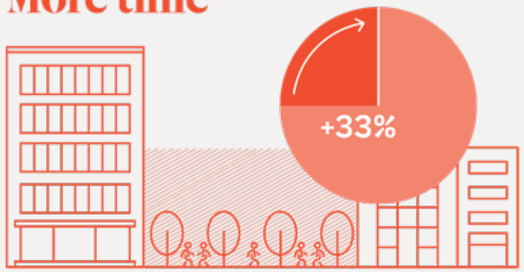
Sidewalk Labs has proposed a public realm vision that would create more space for more people, more of the time. The plans outlined in this chapter achieve the following impacts:

More space

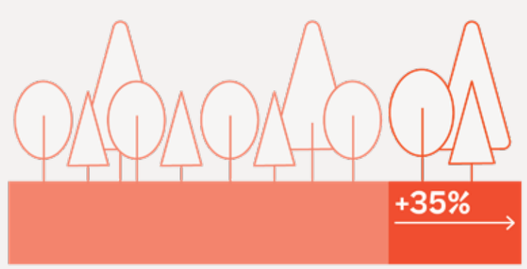


91% more pedestrian open space on major boulevards

More time

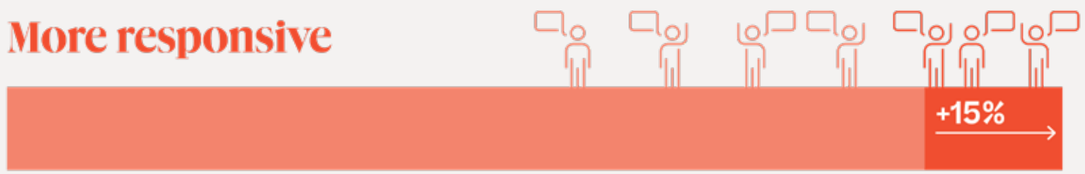


Street life that is activated for 33% more time each day



Outdoor spaces that are comfortable for at least 35% more of the year

More responsive



Programming, operations, and maintenance that is up to 15% more responsive to community needs than it is today

Public consultation spotlight

Six lessons from user research on designing inclusive public spaces

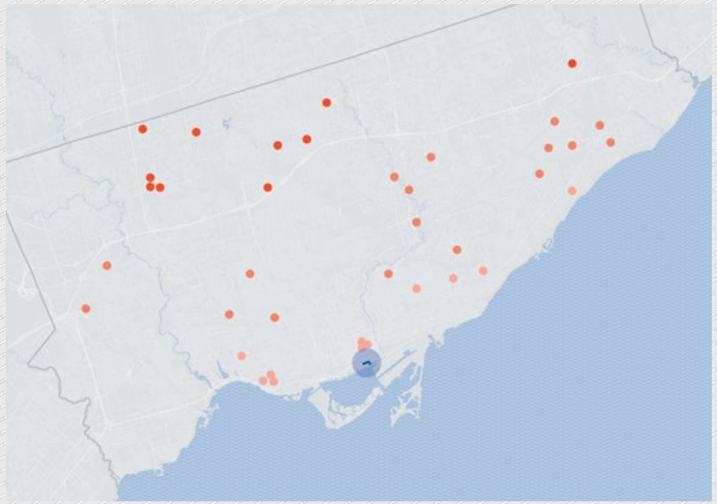
Toronto is ahead of the pack when it comes to using data to study public space. In 2016, the City Planning Department worked with national charity Park People and consulting firm Gehl Architects to conduct a comprehensive study of downtown public spaces as part of TOCore, the city's long-term planning vision.[6] Waterfront Toronto has also conducted extensive outreach on public space, including its "How to Make a Great Park" survey.[7]

To build on that data-driven work during the planning of Quayside, Sidewalk Labs collaborated with Park People and Doblin, Deloitte's human-centred design and innovation practice, on a research study to help inform people-first park design. The partners carefully screened and selected 40 people from across the city to participate in a qualitative research exercise focused on the question: What factors create a sense of belonging and ownership in public space?

Researchers spent an afternoon with participants in their homes or went on walks with participants in public spaces in different neighbourhoods to help answer this question. Most of the participants came from outside of the downtown core, and they had never previously participated in a public consultation process.

In addition to the input heard during the broader public consultation process described on Page 192, the results from this user research effort helped shape Sidewalk Labs' public realm plan and provide a general playbook for how to think about designing inclusive public spaces in diverse cities. (Initial results from the Doblin and Park People study were also shared as part of the broader public consultation process.) Six of the lessons are described on the following page.

Seeking a diversity of voices from across the city



Sidewalk Labs, Doblin, and Park People collaborated on a study exploring how Torontonians use public space, with a focus on reaching out to people normally not included in public consultations. The research participants included a diverse mix of roughly 40 respondents from across the city, weighted towards respondents who live more than 30 minutes from the waterfront by public transit.

Key

- Quayside development
- 0-30 min by public transit
- 30-60 min by public transit
- 60+ min by public transit

A **Design a living room, not a sitting room.**
One of the core lessons from this user research was that people want the opportunity to help shape their public spaces. People are motivated to interact when there is evidence that a place has been used by others. While it is important for public spaces to be well maintained, small imperfections — even a bit of patina or grit — add a human quality that helps people understand that they are invited to contribute.

B **Foster small interactions.**
People crave face-to-face interactions and opportunities for personal connection, however brief. The job of urban design is to encourage people to meet, dwell, and share a moment together in public space. That means integrating interactive features that prompt conversation: public art installations, communal picnic tables, or playgrounds with activities for parents, such as adjacent food and beverage stalls.

C **Promote unique but not unapproachable.**
The best public spaces include recognizable features but still manage to surprise and delight. The job of design is to strike that balance, helping people orient themselves while still delivering a unique experience. That involves placing the known in the unknown (familiar elements in a new context), as well as the unknown in the known (new elements in a familiar context).

D **Build in sensory variety.**
Variety in public space is far more than what a person can see. The job of urban design is to give people the full spectrum of sensory experiences. Smells, sounds, tastes, and textures — these are the traits people remember about a space, and during the design process they risk being overlooked in favour of exterior architectural variety. But sensory variety helps people experience a single space in a personalized context, increasing the appeal to a more diverse community.

E **Set positive rules.**
Signs filled with lists of *don'ts* are stifling, but spaces governed by rules that are hard to decipher are just as problematic. The job of urban design is to create accessible rules that lead with positivity and inclusion. Setting positive rules includes subtle cues, like lights that indicate a space is still open, as well as explicit encouragement — rules that lead by telling community members what they can do, not what they cannot do.

F **Celebrating slowing down.**
Part of the beauty of public space is its ability to help people escape from the speed of everyday life. The job of design is to help celebrate cherished moments of pause, which are increasingly lost to the on-demand nature of society. Striving for a perfectly planned experience eliminates the magic of chance — the chance to see an old friend or stumble onto a new treat. Public spaces are actually better when there is a bit of friction.

Ch–2

Part 1

Creating More Open Space

Key Goals

1
Reclaim street space for people

2
Make the most of new parks, plazas, and open spaces

The shores of Lake Ontario have been outdoor gathering places for centuries. The indigenous communities that first inhabited these lands treated the shoreline and the water itself as integral to their daily lives.

As Toronto has grown into a metropolitan area of six million people[8] with a dense urban core, the desire for abundant public space has remained constant. Toronto has done a lot to preserve access to the water and waterfront space amidst this growth, leading to iconic public spaces like the Islands, new parks like Sugar Beach and Corktown Common, and the ravine network. But in parts of the city, including the downtown core, the provision of open space per capita has shrunk dramatically in the past 10 years with the rise of new residential developments.[9]

According to Toronto's Parkland Strategy, the city's standardized tool for measuring park supply, per capita park space has fallen across the city. In pre-amalgamation Toronto and East York, where it was already scarcest by far, park space declined from roughly 25 square metres per person to 21 square metres from 2006 to 2016. The city's analysis shows that if Toronto adds the 500,000 people projected by 2032, average downtown park space would decline another 4 to 5 square metres per person, unless new space is created.

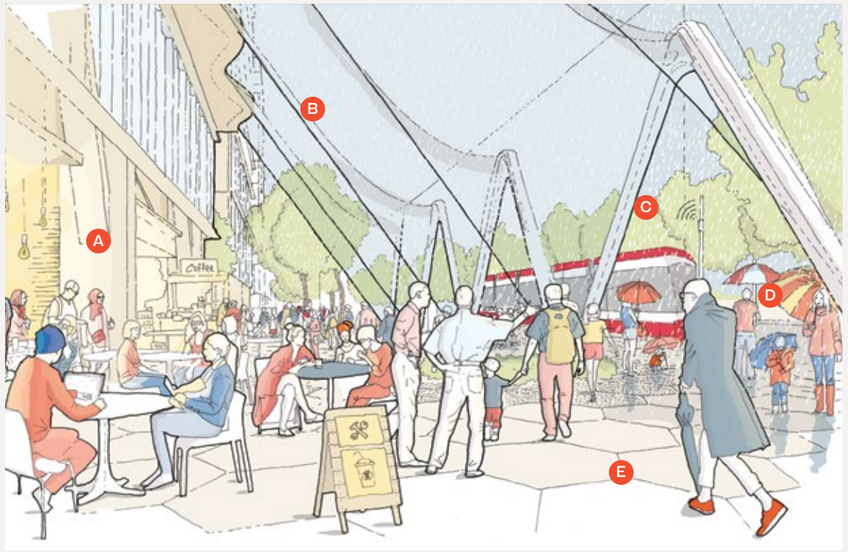
The challenge of preserving or expanding public space amidst downtown growth is familiar to high-demand cities around the world. To help address it, Sidewalk Labs proposes a new approach to street design that would reclaim space for people, and new physical and digital innovations that would help maximize public space in dense neighbourhoods.

Lively streets past and future

Yonge Street – 1902

A celebration on Yonge Street circa 1902.[10] Crowds of people mingle under storefront awnings and spill out into the street, surrounding the light rail transit. Cycling had grown in popularity throughout the city in the late 19th century, and a few cyclists can be seen walking their bikes in the foreground of the photo. Credit: City of Toronto Archives

Queens Quay East



A hypothetical afternoon on Queens Quay East. By then, streets in Quayside could resemble those designed in the pre-automobile era, which provide room for all travel modes.

- A Indoor-outdoor space
- B Building Raincoats
- C Dramatic increase in greenery
- D Dedicated bike lanes
- E Below-ground smart utilities

Goal 1

Creating More Space

Reclaim street space for people

The term “public realm” can conjure up images of a leafy green park. But streets are the type of public space that people use most often in cities, acting as the spines of a connected public realm network. In Toronto, roughly 27 percent of space is devoted to the street network (approximately 5,617 kilometres),[11] while only about 13 percent of space (approximately 8,000 hectares) is devoted to parks.[12]

As in most major North American cities, many streets in Toronto were planned or retrofitted with the private vehicle as the priority. They have narrow sidewalks and rigid crosswalks, making pedestrians feel like second-class street users. Cars parked at the curb take up space that might otherwise be used for trees, bikes, or street furniture. Parents with strollers, elderly people using canes, and people using wheelchairs often struggle to navigate cracked pavement or slippery winter sidewalks. Loud utility work ties up streets for days. There is no easy way to transform a street into true public space.

Toronto has been a leader in progressive street design, including innovative “complete streets” and “green streets” policies. For example, Waterfront Toronto’s revitalization of Queens Quay West turned a previously scant sidewalk into a generous promenade and bike path now used by thousands of people daily.[13] But only select streets realize these ambitious policies. The Sidewalk Toronto project offers an opportunity to advance the city’s vision and demonstrate what is possible when such policies are integrated into the foundation of the neighbourhood from the outset.

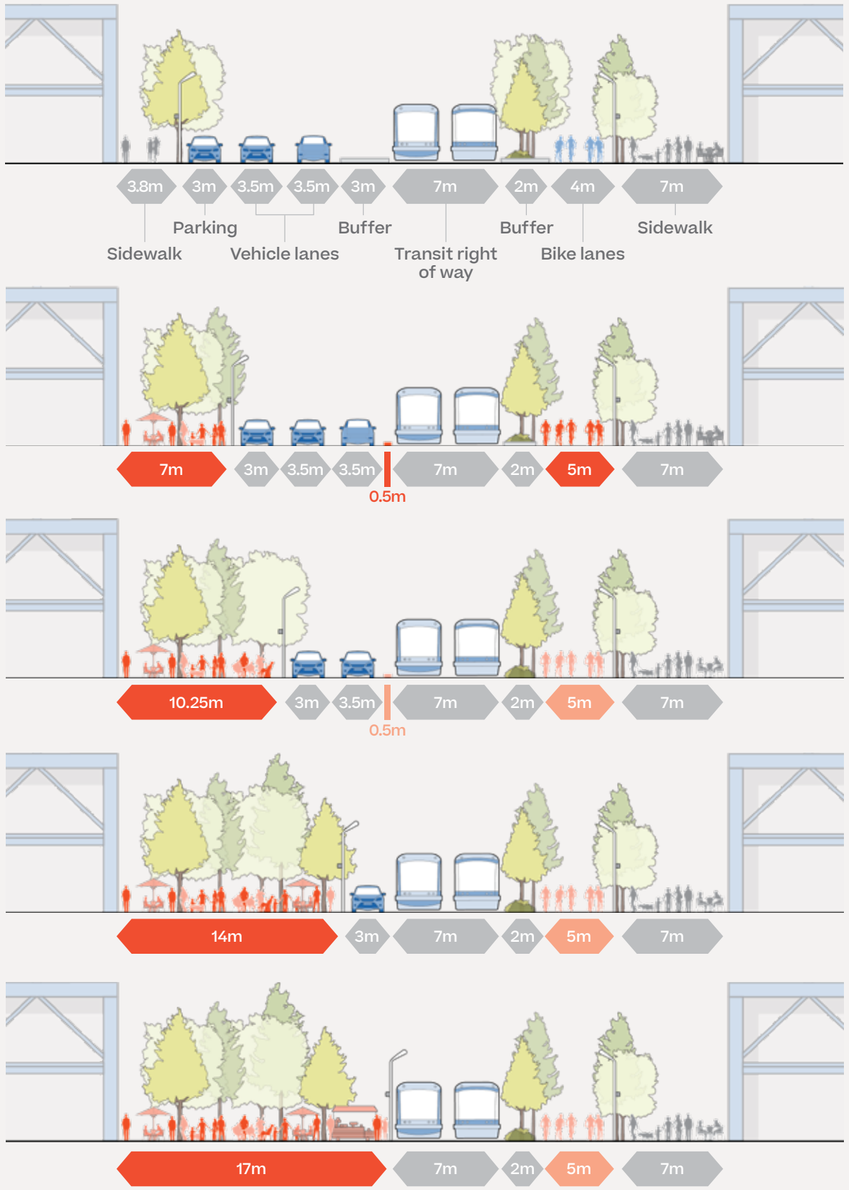
Building on new street designs emerging across the city, Sidewalk Labs plans to reclaim city streets for people, turning streets into lush environments that are truly integrated with parks, plazas, and the water — creating a vibrant, safe network of open spaces for everyone.

By designing streets around a comprehensive mobility system that prioritizes shared (and eventually self-driving) vehicles, Sidewalk Labs could dramatically shrink the amount of street space needed for parking or vehicle travel, while still enabling people to get around the city conveniently and affordably. And by implementing more flexible and resilient pavement and green infrastructure, Sidewalk Labs could advance the aims of complete and green streets policies.

On boulevards in a neighbourhood like Quayside or elsewhere in the IDEA District, this approach would enable street design to include up to 91 percent more space devoted to people and room for nearly twice as many trees compared to the existing precinct plans for Quayside, creating a new norm where space to play and linger is right outside everyone’s door.

A vibrant and safe network of open spaces can be created by reclaiming street space from parking and vehicles.

Four street design innovations that together create at least 91% more pedestrian space



1

Design change: Narrowing lanes and buffers.
Space impact: 28% increase

2

Design change: Reducing the number of vehicle lanes.
Space impact: 57% increase

3

Design change: Sharing transit rights-of-way.
Space impact: 91% increase

4

Design change: Eliminating curbside parking.
Space impact: 91-118% increase

Through a series of measures, Sidewalk Labs plans to capture the potential upside of a shift towards ride-hail and self-driving vehicle services to create more space for people and nature.[14]

Applied in Quayside, the impact of these measures would stretch across all streets, but they would be most visible on Queens Quay — a busy 38-metre boulevard that is typical of most major cities, with all forms of transit and street life.

1 Narrowing lanes and buffers.
Achieving this new balance starts by narrowing the width of vehicular lanes and reducing the adjacent buffer space.

Wide lanes and buffers are planned into boulevards designed for cars travelling at fast speeds, but by prioritizing public transit, cycling, and walking, it is natural to strip back vehicular maneuvering space. European streets are already planned this way, prompting drivers to travel slower and exercise caution, while leaving more space for more sustainable travel modes. With widespread adoption of self-driving vehicles, streets with narrow lanes and buffer areas would become even more safe, because self-driving vehicles would be even more reliable drivers than people are, and could be programmed to stay within a lane's boundaries.

By applying this approach to Queens Quay East, it would be possible to safely reduce both vehicular lanes from 3.5 metres to 3.2 metres and to reduce the total amount of buffer space by 3.5 metres. With this newly created space, a bike lane could be increased by 25 percent and pedestrian space could be increased by 28 percent, over a business-as-usual scenario.

2 Reducing vehicle lanes.
Next, it is possible to regain space by reducing the number of lanes devoted to vehicle traffic.

This design is enabled by reductions in private vehicle travel that would result from public transit expansions, improved cycling infrastructure, and new mobility options, such as ride-hail services that would eventually become self-driving vehicles. A coordinated mobility system that routes drivers (or self-driving vehicles) around heavy-traffic areas would also support this design shift.

By applying this approach to Queens Quay East, it could be possible to reduce a vehicle lane over time, leading to a cumulative 57 percent increase in pedestrian space over a business-as-usual scenario.

3 Sharing rights-of-way.
Lastly, Sidewalk Labs plans to encourage the sharing of rights-of-way among public transit vehicles (such as light-rail vehicles) and self-driving vehicles, once those become ubiquitous.

While sharing lanes today usually results in slower transit times because cars travel at variable speeds and may get into collisions, Sidewalk Labs is studying the potential for self-driving vehicles to share the right-of-way without hindering transit efficiency. This approach would become possible because self-driving cars could be programmed to travel at the same consistent speed as a public transit vehicle and stay in a narrow lane. These capabilities would support the priority of public transit and keep service flowing smoothly, while freeing up additional space for pedestrians.

Applied to Queens Quay East, the ability to have public transit share a right-of-way with self-driving vehicles would enable the closure of another vehicular lane, leading to a cumulative 91 percent increase in pedestrian space over business as usual.

4 Eliminating curbside parking.
Additional, temporary space gains could come through the ability to eliminate fixed curbside parking and replace it with flexible drop-off and pick-up zones that would be actively managed throughout the day — a concept called the "dynamic curb" that is fully compliant with the Accessibility for Ontarians with Disabilities Act (AODA).

Shared or self-driving vehicles help make this design possible, since they move immediately from one passenger to the next without needing to wait for long periods at the curb. To further discourage standing vehicles and reduce traffic congestion, Sidewalk Labs proposes to apply curbside pricing.

Applied on Queens Quay East, 3 metres of width would be reserved for flexible pick-up and drop-off zones. As demand for pick-up and drop-off declines based on time of day, those spaces could be individually reprogrammed as expansions of the sidewalk for uses like more café tables during lunch. When a space is open for pedestrians, it would be clearly marked as unavailable for vehicles through digital signage, lighting, and movable street furniture arranged to form a physical barrier.

When all dynamic curb spaces are open to pedestrians, which would occur during very low pick-up and drop-off periods (such as late evening), there would be a 118 percent increase in pedestrian space over a business-as-usual scenario.

See the "Mobility" chapter of Volume 2, on Page 22, for more information on pricing.

New Road in Brighton & Hove on the South coast of England was converted to the U.K.'s first shared street in 2007. The street was redesigned as a flat surface without curbs or crossings, giving pedestrians priority over other types of transit. Credit: Gehl

Going curbless.

To facilitate the expansion and contraction of public space throughout the day, Sidewalk Labs proposes to design a fully curbless street. Unlike a typical street with a hard curb separating street from sidewalk, the entire street would be at one consistent grade, enabling the sidewalk to grow or shrink quickly and easily.

The notion of a curbless street builds on a design innovation used for years by Europeans, particularly the Dutch. A curbless street is shared by pedestrians, cyclists, and slow-moving vehicles. Though it may seem counterintuitive at first, much like narrower lanes, this shared-streets design has been found to increase safety, because it forces drivers to be hyper-vigilant at very low speeds. There is growing global momentum around shared streets, with popularity growing in Toronto, where the first shared street opened in 2015 in the West Don Lands, shortly followed by a revamped Market Street in the St. Lawrence neighbourhood.[15]

Ensuring these streets remain inviting for people who are visually impaired is essential and could be accomplished through responsive sounds and tactile pavement.

A curbless street enables the quick and easy expansion and contraction of public space throughout the day.

Adaptable streets in action: Future evolution of Queens Quay

At 8 a.m., this dynamic curb space could open to vehicles dropping off commuters at work.

After 8 p.m., as commuter traffic slows, select pick-up and drop-off zones could be used for mobile food pop-ups or movie screenings.

Thinking of streets as parks: Programmed and green

Taking full advantage of curbless streets and expanded sidewalks means thinking of streets more as parks — deserving of their own programming and flush with greenery. As more cities push to reimagine streets for public uses, this approach can be emulated on wide boulevards as well as smaller local streets.

Queens Quay West significantly advanced the design of tree-rich urban boulevards in Toronto and North America. In Quayside, on Queens Quay East, Sidewalk Labs proposes to advance this goal even further and demonstrate a world-leading model for greening a major boulevard. Over time, the result would be a roughly 5,486-square-metre linear park in Quayside, with movable tables and seats set beneath clusters of trees.

For Queens Quay East, Sidewalk Labs is proposing a forest model successional planting strategy, where a mix of understory and canopy species are clustered together and share soil in large beds. This approach to street-greening would deliver streetscapes that not only feel like parks but create the conditions to support increased biodiversity and improve the resiliency of the urban forest. It would also result in more apartments and offices having sightlines to green space than comparable downtown areas.

Additionally, all of these trees would have the 30-cubic-metre soil volume set out in the Toronto Green Standard, resulting in healthier trees.

A future Queens Quay could have

95 trees per hectare

almost doubling the number of trees relative to Queens Quay West today.

See the “Sustainability” chapter of Volume 2, on Page 296, for more details on stormwater management.

In addition to these ecological benefits, on Queens Quay East in 2025, it would be possible to plant trees at a concentration of 59 trees per hectare, a 20 percent increase over the concentration of 49 trees per hectare achieved on Queens Quay West today. In a future Queens Quay East, when vehicle lanes could be closed thanks to self-driving vehicles and additional trees could be planted, it would be possible to achieve 95 trees per hectare,[16] almost doubling the number of trees relative to Queens Quay West today.

These measures are good for the environment, because a green landscape sequesters carbon, absorbs particulates, helps mitigate the urban heat island effect, and reduces the risk of flooding.[17] Green infrastructure in streets is also a key component of advanced approaches to stormwater management that design cities in concert with nature.

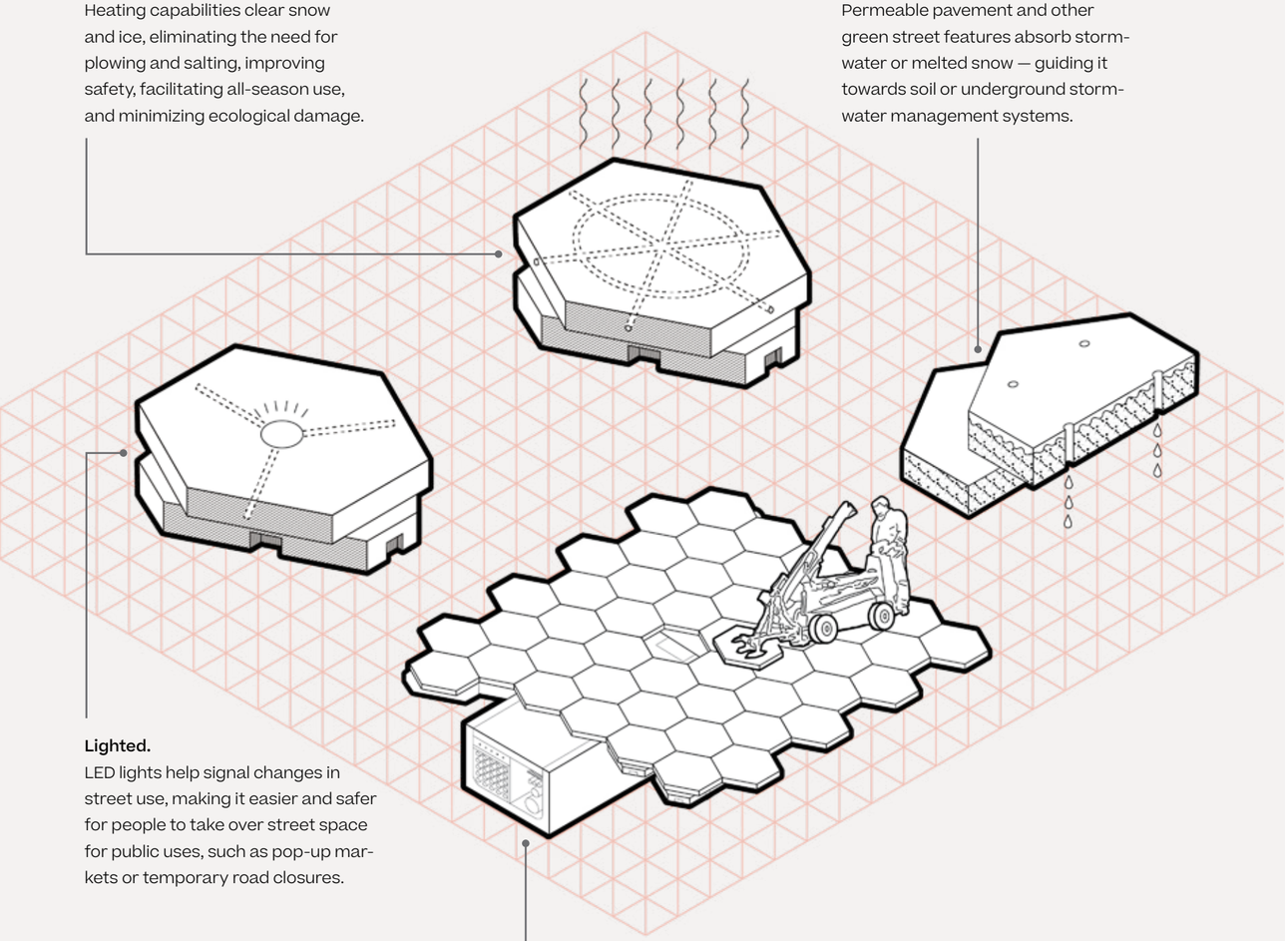
Extensive behavioural evidence has found that greenery promotes the health and happiness of residents and workers more generally.[18] For example, a 2015 study of Toronto found that having just 10 more trees on a block was comparable, on average, to being seven years younger in terms of self-reported health outcomes, controlling for other socio-economic factors.[19]

Heated, lighted, green pavement

Throughout the MIDP, there are a number of references to advanced pavement capabilities, such as heating, lighting, and permeability. Sidewalk Labs proposes to bake all these facets into its modular pavement, forming an ambitious pavement combination that has not yet been achieved.

Heated.
Heating capabilities clear snow and ice, eliminating the need for plowing and salting, improving safety, facilitating all-season use, and minimizing ecological damage.

Green.
Permeable pavement and other green street features absorb storm-water or melted snow — guiding it towards soil or underground storm-water management systems.



Lighted.
LED lights help signal changes in street use, making it easier and safer for people to take over street space for public uses, such as pop-up markets or temporary road closures.

Modular pavement and open access channels could work as a pair to increase the ease of utility work.

Modular pavers could be easily removed or replaced in less than half a day.

Deploying modular pavement to facilitate utility access and street repairs

Reclaiming streets for people involves more than just filling space left over by vehicles. It also requires reconsidering how streets are paved, and the role that streets play in providing access to underground utilities.

Traditional streets are constructed with rigid pavement that degrades over time, especially as the street is cut up to repair and install new underground utilities. Utility-related street cuts in Toronto have nearly tripled since 2000,[20] and the city now evaluates more than 50,000 utility work permits annually.[21] Each cut is a time- and cost-intensive endeavour that discourages rapid innovation and investment in new infrastructure, such as fibre-optic cables that have become a basic need for homes and businesses.

To tackle this challenge, Sidewalk Labs plans to implement a modular pavement solution coupled with open access channels consisting of precast concrete sections, enabling streets and the infrastructure they house to evolve as technology changes.

Sidewalk Labs has prototyped this new approach to street design at its Toronto-based office, 307, inspired by a pilot project in Nantes, France, to address disruptive street and utility maintenance in cities. In the mid-2000s, the French Institute of Science and Technology for Transport, Development, and Networks (IFSTTAR) designed a modular paver system, consisting of hexagons that are easy to remove and replace. In IFSTTAR's system, one person can perform a standard utility cut in less than half a day using a small hand-operated machine featuring suction cups or levers. After testing at its research facility, IFSTTAR installed pilot streets, including one in Nantes that has endured 10 years of heavy truck traffic while remaining stable and requiring no maintenance.[22]

Building on the Nantes design, Sidewalk Labs has prototyped a modular pavement system consisting of thick concrete slabs with interlocking lap joints that would provide equal or better performance as a traditional road. The sub-base would consist of a bed of granular material specifically engineered as part of the pavement section based on anticipated traffic volumes, vehicle loads, soil sub-grade characteristics, and climate.

Sidewalk Labs recognizes that this new approach to street systems would require changes to existing regulations and operations. In 2019, Sidewalk Labs plans to work with local universities and regulators to refine the prototype and develop a pavement that would work in a Toronto context.

Further, Sidewalk Labs proposes to couple modular pavement with open access channels that provide easy access to utilities. Each channel would be about 1 metre deep by 2 metres wide, with a removable lid built into the modular pavement. These channels would house "dry utilities" distribution, including power, street lighting, and information communications technologies, such as fibre optics. The channels would be fitted with spare conduits (protective tubes for electrical wiring) and would include additional capacity for the expansion of existing utilities or the emergence of new ones.

Modular pavement coupled with open access channels would have a number of important advantages over traditional pavement and buried utility systems.

Fewer disruptions.
A conventional utility street cut typically takes a full crew of road workers and trucks several days to remove and restore pavement — a disruptive, noisy process that impacts street life. With modular pavement, an equivalent utility street cut could be made by one person removing and replacing the pavers in less than half a day. The addition of open access channels further reduces the amount of time that would normally be dedicated to trench excavation and backfill, lessening the disruption to businesses, residents, visitors, and traffic. Modular pavement would also eliminate the patching that results from utility work, improving the aesthetic and texture of the street. About 20 percent of the total street surface in Toronto is cut and patched to access underground utilities over a given 30-year period.[23]

Greater flexibility.
The inherent flexibility of modular pavers and open access channels would provide greater access for routine maintenance and enable streets to change over time. With conventional pavement and buried utilities, transformations to street and underground infrastructures can be cost-prohibitive, creating a significant barrier to advancements. Sidewalk Labs' proposed system would make infrastructure transformations possible in days at a fraction of the current costs. Suddenly, it becomes fast and affordable to swap out a dozen sidewalk pavers for a community garden, or lay out a new communications infrastructure network with higher performance capabilities.

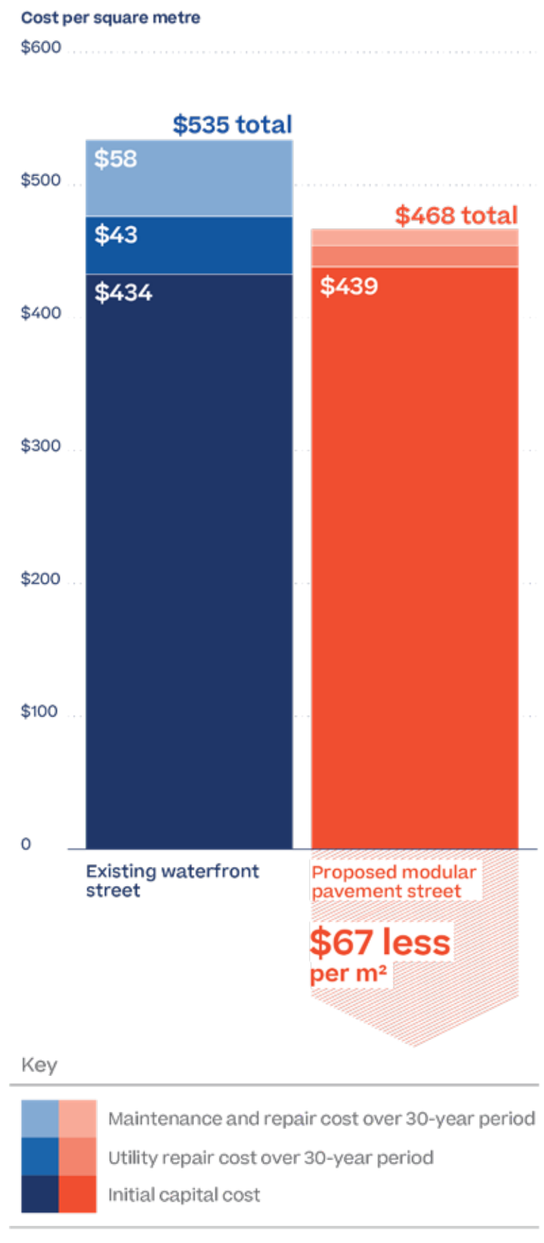
Less cracking.
In 2017, Toronto city staff received requests to fix 214,253 potholes.[24] Cracking in typical roadway pavement tends to occur at the sharp, 90-degree angles of rectangular slabs. Sidewalk Labs' modular pavement prototype has a greater ability to resist wear and tear, because a hexagon's 120-degree angles distribute vehicle weight more evenly than rectangles do, and the smaller dimension of the modular paver allows for subtle movements that reduce cracking overall. Additionally, heating capabilities (described further in the "Mobility" chapter) would reduce damage from the seasonal freeze-and-thaw cycle.

Lower long-term cost.
Sidewalk Labs estimates that over a 30-year period — the standard unit of time used to analyze road performance — modular pavement coupled with an open access channel system would be 13 percent less expensive per square metre than the standard waterfront streetscape in Toronto today. Installation costs for pavement construction would be similar, as would the cost of constructing the open access channels (relative to burying utilities). But savings would accrue over time due to significantly lower maintenance and repair costs ($12 per square metre versus $58) and the lower cost of utility repair that results from easier access and accelerated road work ($17 per square metre versus $43).[25]

In addition to being less costly to maintain and repair, modular pavement makes it fast and affordable to use street space in new ways.

Modular: 13% less costly than standard pavement

Modular pavement coupled with open access channels can create savings driven by lower maintenance and repair costs, as well as the lower cost of utility repair.



Goal 2

Creating More Space

Make the most of new parks, plazas, and open spaces

Reclaiming streets for people is a critical step in creating more public space in downtown neighbourhoods, but wider sidewalks are not a replacement for traditional parks, plazas, and open spaces. In fast-growing cities like Toronto, population and market pressures can lead new developments to devote as much space as possible to buildings. That density is critical, but if it comes at the expense of a vibrant network of open space, the quality of life suffers.

Toronto is ahead of the curve in planning a proactive response. The city's Parkland Strategy includes a robust tool for mapping priority areas for new parks, and its 20-year Facilities Master Plan outlines a sound, future-looking strategy for delivering recreation outposts.[26]

Sidewalk Labs plans to build on such efforts to ensure access to high-quality open spaces that meet the needs of a community in two key ways. First, it has developed a data-driven planning and evaluation tool called "generative design" to identify opportunities for more open spaces that complement a city's existing park network. Second, Sidewalk Labs plans to embrace multi-use, flexible public space design to deliver parks, plazas, and open spaces that are better able to accommodate the diverse needs of an expanding population.

Generative design can help planners:
→Increase open space
→Increase daylight access
→Increase density

Maximizing open spaces using "generative design"

Urban planning involves navigating a series of tradeoffs. For example, achieving one development objective (such as access to sunlight in public spaces) might impact the ability to achieve another (such as building higher for population density).

To help inform that decision-making process, Sidewalk Labs has developed a generative design tool that uses computational design, machine learning, and improved simulations to show urban planners many possible choices and their impacts, often producing surprising results. Planners could then use these insights to evaluate key decisions, with increased confidence in how their plans would play out in real life. They could also use the tool to show stakeholders how their concerns would be represented in a development.

For the Sidewalk Toronto project, Sidewalk Labs plans to use the tool to explore this outcome in areas across the IDEA District, such as Villiers Island.

Planning for more courtyards.
Villiers Island is already planned to be encircled by one of the world's most extraordinary new parks through the naturalization of the Don River. This 16-hectare park will be a destination for the entire region.[27]

In Villiers East, a new pedestrian-first street network could be designed to create a series of intimate walkways and courtyards.

Because there is so much park space dedicated to the island's perimeter, there are no dedicated parks in the neighbourhood's interior.

Generative design could be used in the Villiers development process to enhance the amount of quality open space in the neighbourhood's interior, while still increasing density and thus important access to housing and jobs. The existing Villiers Precinct Plan contemplates the idea of breaking down the development blocks into series of small buildings with pedestrian courtyards, creating more intimate environments where residents can mingle. As planning proceeds in Villiers, the generative design tool could help evaluate the performance of different courtyard options by running thousands of simulations that weigh factors such as building massing, lighting, and wind.

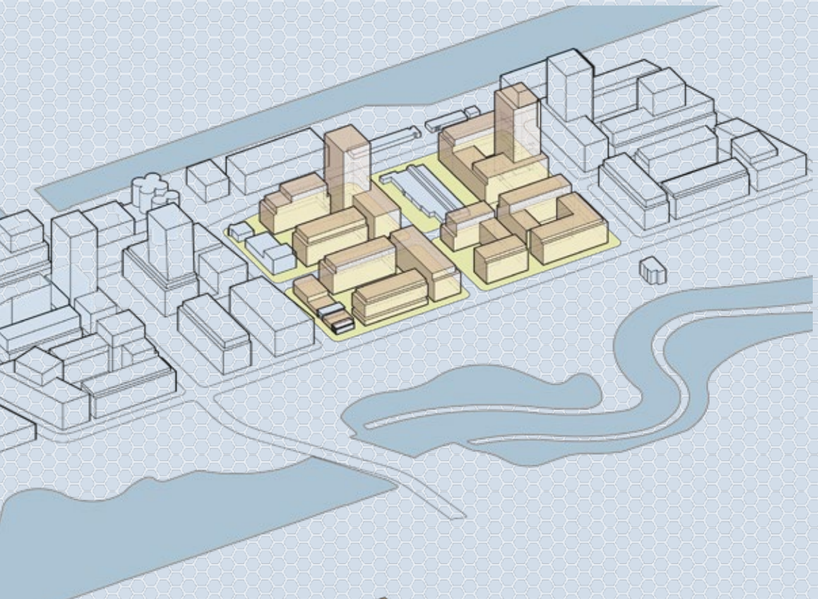
To test the tool's capabilities, Sidewalk Labs conducted a preliminary study of possible courtyard configurations for a two-by-two block area of Villiers, aiming to optimize for three variables: percentage of open space, sunlight access in the courtyard, and density (gross floor area). In an initial run, the tool generated and analyzed thousands of permutations and surfaced roughly 400 plans that outperformed the precinct plan on these three specific variables (see Page 142). For example, one scenario (Run #01140) demonstrated the ability to increase open space by 12.6 percent, while still increasing daylight access by 8.6 percent and density by 496,781 square feet.[28]

The resulting interior spaces would play an important role in supplementing the city's park network as intimate neighbourhood spaces, each distinct from the other. These spaces would create important pedestrian connections across the island and provide residents and workers with access to open space right outside their door. They could resemble, for example, the open areas that link certain housing blocks in Helsinki, or the alleys and courtyards that link Hutongs in Beijing.[29]

Through applying this planning and evaluation tool across development areas such as Villiers, planners could finesse buildings and street grids to carve out these pocket-sized, quality open spaces, creating forums for community bonding.

In Focus

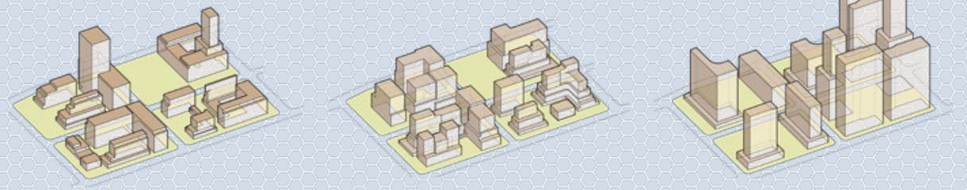
Helping planners analyze thousands of options



A generative design analysis of a two-by-two block in Villiers Island produced roughly 400 plans (out of thousands of permutations) that outperformed the existing pre-cinct plan on open space, daylight access, and density.

Precinct plan

Open space	45.3%
Daylight access	49%
Total GFA	1,513,144 ft²



Generative design #00530

Open space	5.2% increase
Daylight access	13.6% increase
Total GFA	+24,243 ft²

This run was created through making marginal changes to the precinct plan; it has small increases in open space and density, and a large increase in daylight access.

Generative design #00469

Open space	3.31% increase
Daylight access	20.61% increase
Total GFA	+196,710 ft²

This run was created through making moderate changes to the precinct plan; it has a small increase in open space, a medium increase in density, and a large increase in daylight access.

Generative design #01140

Open space	12.6% increase
Daylight access	8.6% increase
Total GFA	+496,781 ft²

This run was created through making significant changes to the precinct plan; it has a medium increase in daylight access, and a large increase in open space and density.

Designing flexibility into parks, plazas, and water spaces

A generative design tool could help urban planners map out the distribution of open spaces to ensure equitable access across a given development area. Another way to ensure access is to design facilities that are more flexible, enabling them to cater to the widest possible variety of people.

The traditional approach to designing open spaces is to plan them with a fairly prescribed purpose in mind. A swingset here, a baseball diamond there, a basketball court in another corner. Once the space opens, the community is expected to use it in those very specific ways. But such inflexible designs often struggle to meet the diverse needs of a growing population and accommodate evolving preferences.

Flexible open spaces can be quickly reconfigured by day or by season.

Like many cities, Toronto built a lot of its parks and recreational facilities decades ago; its average rec centre is nearly 40 years old.[30] Many favourite activities from back then have lost their appeal: the number of youth enrolling in hockey has shrunk, while sports like soccer have become more popular. Demographics have shifted; walking tracks and pickleball courts are now big hits with the city's growing elderly population. New trends and technologies arrive. Community kitchens are all the rage, and Wi-Fi has become a necessity when delivering new public space.

This shift underscores a larger insight: Given the constraints on open land in dense urban cores, it is critical for these types of spaces to be designed in ways that are flexible, and therefore more usable, by more people over time.

To create a network of open spaces that can be shaped and reshaped in response to community needs, Sidewalk Labs plans to infuse its parks, plazas, and water spaces with significant flexibility from the start. Using design practices focused on multi-use spaces and technology advances around movable infrastructure, Sidewalk Labs proposes to create multi-purpose parks that could serve a host of different users, flexible plazas that could be quickly reconfigured by day or by season, and adaptable water spaces that could draw people to the lake year-round.

Flexible principles such as play features and movable furniture can help maximize the diversity of uses within urban parks.

Multi-purpose parks.
Cities around the world have started to make better use of their limited park space through multi-purpose design and new technology tools.

The Athletic Exploratorium in Odense, Denmark, has a topography designed to facilitate a multitude of different sporting events.[31] Klyde Warren Park in Dallas brings together diverse residents from across the city and is able to fit a stage, a splash pad, an outdoor reading and games room, a dog run, food, and community art in a 2.1 hectares park on top of a freeway.[32]

Low-cost lighting makes it possible to imagine a single court embedded with lights that could redefine its space for basketball or street hockey at the push of a button.

Sidewalk Labs plans to work with Waterfront Toronto and the City of Toronto to maximize the diversity of uses within urban parks, with a number of flexible principles in mind.

Designing Silo Park using multi-purpose planning principles

By incorporating flexibility into its foundation, Silo Park can become a lively public space that brings together people of all ages across all seasons.

In Quayside, Sidewalk Labs hopes to work with Waterfront Toronto and Toronto Parks, Forestry, and Recreation to build multi-purpose recreational infrastructure into Silo Park by applying the following principles:

- **A** All courts and fields must be designed to accommodate at least three sports in the same space.
- **B** All recreational spaces must be designed to be active and accessible year-round.
- **C** At least one “play” feature must be incorporated that has activities designed for users of all ages.
- **D** At least 90 percent of furniture must be easily movable.
- **E** There must be a space for regular food and beverage.

Initially, these principles could inform the approach to Silo Park in Quayside and, based on their success there, potentially be adopted elsewhere.

Campo de' Fiori, in Rome, uses flexible plaza design to shift uses throughout the day. Credit: iStock

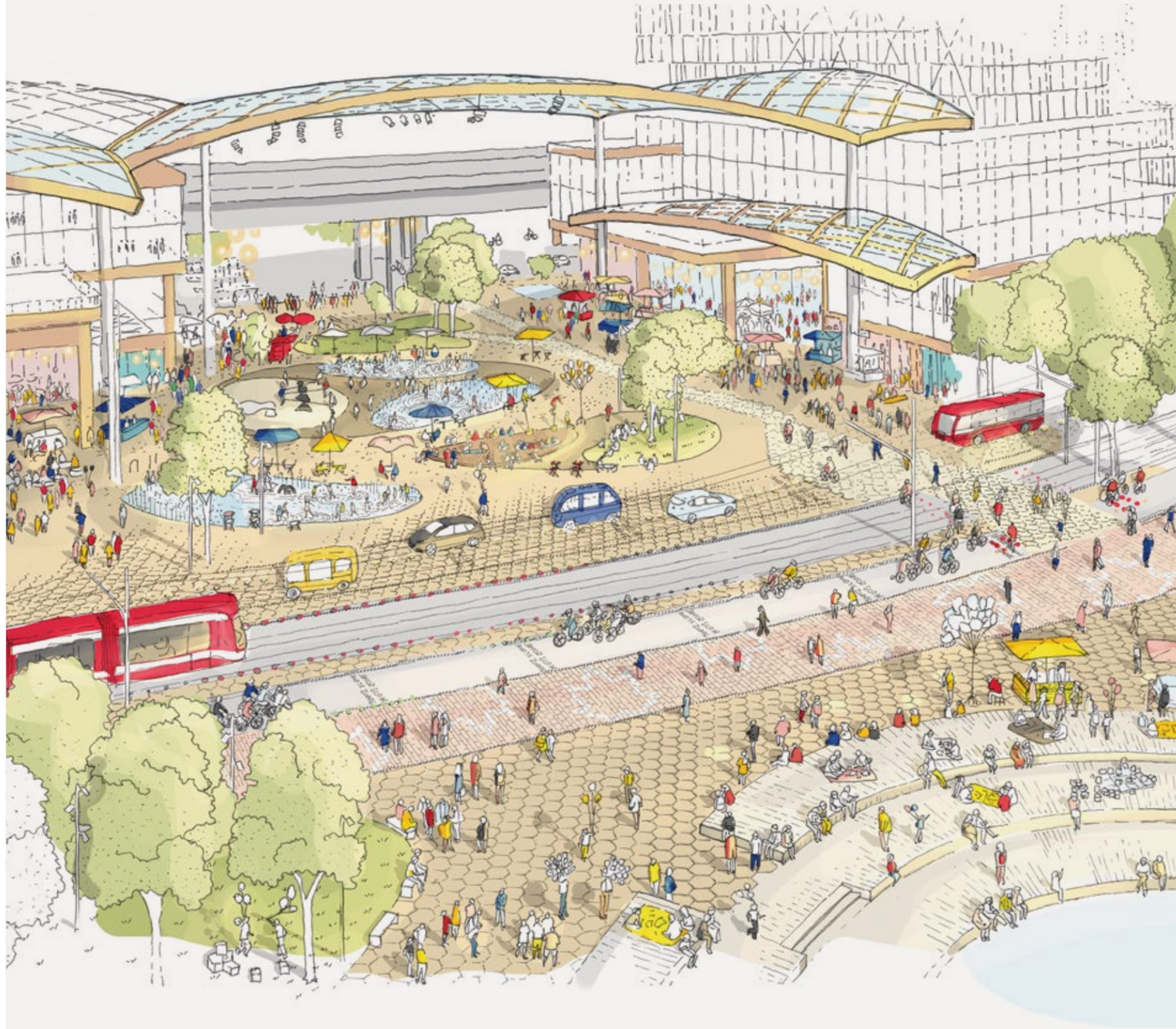
Flexible plazas.
The world's best plazas are naturally flexible, giving the same space many different lives. Often this goal is achieved with simple, lightweight, adjustable street furniture that people can move around to meet their needs. In Utrecht, for example, visitors can "pop-up" a series of benches and other street furniture elements on demand.[33] In Rome, the Campo de' Fiori transforms from market to nightlife destination by shifting around stalls and seating throughout the day.[34]

Drawing from these precedents, Sidewalk Labs plans to design flexible plazas that balance the stability of permanent features with the spaces that are open to ongoing community programming.

For example, in Quayside, Sidewalk Labs plans to design Parliament Plaza with convertible capabilities in mind. On a Saturday in summer, the plaza could be totally flat. Children could play in a splash pad while parents stroll through the markets spilling out from the stoa. In the evening, the splash pad could convert into mist machines that form a public art installation when mixed with movable lighting from a nearby canopy, turning the whole space into an interactive public theatre. In winter, that same flat splash pad surface could be turned into a free skating area.

Parliament Plaza

At the heart of Quayside, Parliament Plaza would be a flexible space well-suited for markets, public art installations, all-ages play, and events that integrate with surrounding buildings.



Parliament Slip

At the 6,000-square-metre Parliament Slip, residents, workers, and visitors could connect directly with the water via a new "cove" feature (Parliament Cove), as well as a stretch of dedicated parkland running along the slip's eastern edge.

The Islands Brygge Harbour Bath, in Copenhagen, helps to connect people to the water for recreation or travel. Credit: Rasmus Hjortshøj for Bjarke Ingels Group

Water-bound spaces.

Water-bound spaces often struggle to make room for all the community groups who hope to use the water in different ways, from water rituals to kayaking to fishing to sailing. But many cities have made progress improving the use of their waterfront spaces through a variety of means.

In Toronto, the Port Lands Flood Protection work includes a plan to increase water access through a naturalized Don River mouth. This new park will provide beaches, kayak launches, and wetlands, all features that do not currently exist on the central waterfront today. In Copenhagen, the harbour baths carve out space for lounging and swimming in the middle of downtown; public harbour buses, recreational motor boats, and even bookable floating hot tubs all share the waterway.[35] More than 200 *splavs* — Serbian for "floating lounges" — anchor themselves in Belgrade's rivers, appealing to a diverse crowd.[36]

Inspired by these precedents, Sidewalk Labs proposes to deploy a series of barges in Lake Ontario that are designed for community water-based programming across the seasons. At Quayside's Parliament Slip and throughout Keating Channel, a series of five-by-five-metre barges would be designed to accommodate a range of rotating uses: a research field station to study local ecology, a waterfront classroom, food growing on water (a progressive technique known as "aquaponics"), bars and cafés, or more. Every season would present a new programming opportunity for all ages.

Ch–2

Part 2

Making Open Space More Usable More of the Time

Key Goals

1
Reinvent the role of the ground floor

2
Design an outdoor comfort system for all seasons

Reclaiming street space and maximizing access to parks and plazas is the start of bringing more people together in the public realm. The next step is creating the conditions to ensure that those spaces remain active throughout the day, across the seasons, and over the decades as neighbourhoods evolve.

Promoting vibrant street life is a challenge that continues to vex many cities around the world, including Toronto. The separation of 9-to-5 business districts from the places where people live leaves parts of the city vacant at night, a challenge Toronto is trying to address through its Complete Streets Guidelines. Harsh winters empty out public spaces,[37] and the shift to an online, on-demand economy threatens to uproot the role of ground-floor retail.

To help tackle that challenge, Sidewalk Labs has a two-part strategy that integrates new digital and design capabilities to make public space more usable more of the time.

The first part of the strategy leverages adaptable building structures and flexible leasing tools to create ground-floor spaces that would be far more diverse, active, and inviting than traditional ground-floor retail strips. The second part uses real-time climate data and a set of deployable weather-mitigation fixtures — such as retractable awnings and inflatable shelters — to create an outdoor comfort system that would dramatically expand the amount of time the public realm is usable.

Goal 1

Reinvent the role of the ground floor

There is a long history of street-level markets serving as vibrant public spaces. One of the most iconic examples is the agora of Ancient Greece.[38] These central squares were not just places for merchants to sell things, but also civic centres meant for general community engagement. They were framed by covered walkways called “stoa,” where vendors sold goods and the public gathered to debate new ideas — from the Hippocratic Oath, to the Pythagorean Theorem, to the practice of democracy itself.

Modern cities often reserve the ground floor for retail or expansive office lobbies, but those spaces tend to be closed off from the street and built largely for commercial purposes. As a result, the ground floor plays a limited role in promoting street life, and is constrained in its ability to accommodate other community uses.

The past decade has also seen traditional retailers dying off, as the meteoric rise of e-commerce, the rigidity of long-term lease agreements, and soaring rents that incentivize landlords to hold out for high-value chains have led to papered storefronts. The retailers who have performed best amid these shifts are those who recognize that their stores are less about selling things and more about creating memorable experiences.[39]

Ground floors should be about more than retail. They should be forums for civic exchange.

Toronto’s retail corridors have fared better than retail corridors in other major cities, like New York and London, in part because Canadians have been slower to adopt online shopping, with per capita annual online spending in Canada roughly half that in America ($2,319 to $4,552).[40] But Toronto has seen a few high-profile closures, including the 2018 shuttering of Sears Canada.[41] As online shopping continues to grow, the future of brick and mortar remains unknown.

These conditions set the stage for the next evolution of the ground floor: a return to the public markets of an earlier time, blending an assortment of uses from maker spaces to community meeting spots to food stalls, as well as traditional retail stores.

To catalyze this shift, Sidewalk Labs plans to devote its ground floors to a 21st-century stoa structure — with a flexible, bare bones core and shell system that opens to the street, supplemented by a digitally managed leasing and operations platform. These tools would allow a supply of ground floor space to stay in lockstep with the market forces increasingly driving towards experience-based consumption. As in Ancient Greece, the stoa would enable ground floors to be about far more than just selling goods: they would feel like a bustling marketplace that spills onto the street, where people could converge to exchange ideas.

Ground-floor space that is activated 33% more time each day

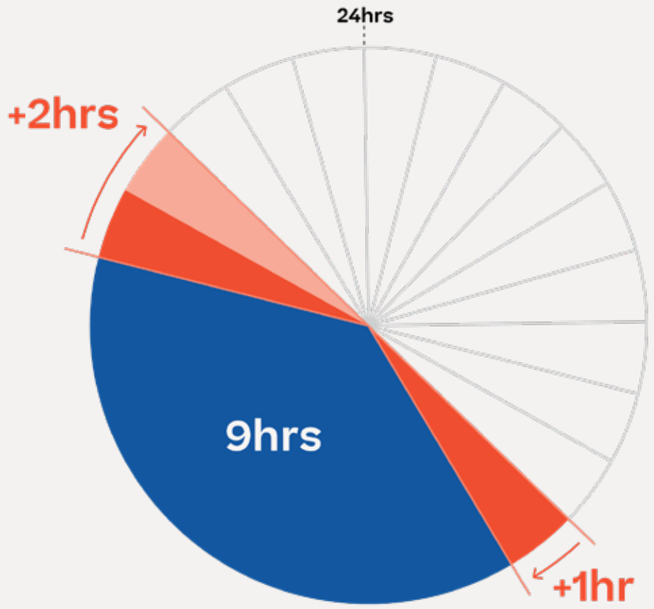
A typical street in Quayside would have a more diverse program mix and more flexible co-tenancy options, leading to three hours more daily activity relative to the weighted average of Toronto street activity today.

9hrs
10am - 7pm
Average street activity today across destination, local, and downtown streets

12hrs
9am - 9pm
Average street activity for the Sidewalk Toronto project

+33%*
More street activity

* A street is considered active when one-third of businesses or more are open.



Diverse program mix

Quayside's stoa space is designed to accommodate a more diverse program than ground-floor spaces on typical downtown, local, and destination streets elsewhere in Toronto, enabling an ongoing mix of traditional retailers, pop-ups, community spaces, light production, and other uses.

Co-tenancy options

Tenants with complementary opening hours (such as a retailer and a bar) would be able to share a lease, and Sidewalk Labs estimates that 20 percent of tenants would use this co-tenancy option, extending the projected street activity even more. Stoa naturally encourages the sharing of space by different types of tenants, and co-tenancy would be further encouraged through Sidewalk Labs' proposed digital leasing and operations platform.

At the neighbourhood scale of Quayside, the planned diverse mix of ground-floor tenants would help expand the amount of time the street is active by two hours a day, relative to other Toronto retail corridors. In addition, a new digital platform designed to encourage co-tenancy and use of space during off-peak hours could increase activity by an additional hour a day. Together these advances would produce a 33 percent increase in the amount of time the street is active.[42]

At a greater development scale across the IDEA District, ground floors could become diverse micro-neighbourhoods unto themselves. Keating Channel could become the new heart of an integrated neighbourhood that spans the canal, with both sides brought to life through small retail stalls on the water's edge that could be connected to large, open-air market spaces. Within the heart of Villiers Island, stoa could spill into neighbourhood plazas at key intersections. In old industrial buildings, large caverns could become hubs of activity, from markets to light manufacturing to community services.

Reimagining ground-floor space in this way would bring the public realm that much closer to the goal of getting people to spend more time outdoors together.

Providing a flexible shell for exploration

Today, most ground floors are constructed to meet the needs of a new tenant that is expected to move in on Day One. If a building is intended for a restaurant, the developer would design the ground floor with servicing for a kitchen and a dining area. If a building is intended for an industrial user, the developer would design a factory floor. The rigidity of these fit-outs means accommodating a new layout in the future may be cost-prohibitive.

Sidewalk Labs small research grant

The changing face of street-level commerce

In 1970, Toronto pioneered the now-common concept of business improvement districts to revitalize neighbourhood shopping (the Bloor West Village BIA was the first in North America).[43] Today, new trends reshape the urban retail landscape, and Toronto continues to push urban retail innovation. A report by Ryerson University's School of Urban and Regional Planning, commissioned by Sidewalk Labs,[44] pulled out a few of these innovative retail concepts:

Credit: Vince Talotta via Getty Images

Market 707.
Repurposed shipping containers on the grounds of the Scadding Court Community Centre, filled with pop-up retail concepts, from food vendors to tattoo parlors.[45] First established in 2011, the containers not only offer short-term leases, but Scadding Court also provides wrap-around entrepreneurship programs for first-time business owners.

The Nooks.
Located on Danforth at Woodbine, the Nooks is an incubator for artisans and producers of handmade goods. As many as 120 entrepreneurs sell their goods in exchange for a membership fee. Like Market 707, the Nooks also offers business coaching and workshops for its members.

Concepts such as these have key ingredients in common that respond to the realities of urban retailing today: affordable spaces, shorter lease terms, shared services, and entrepreneurial supports.

Stoa: Designed to create flexible ground floors

A series of architectural choices enable stoa space to change inexpensively over time, accommodate a range of uses, and support businesses as they grow.

A **Double-storey ceiling heights** create sufficient vertical space for a variety of interior uses.

B **Spacious column bays** make it easier to subdivide the same space for new uses.

C **Deconstructable partitions** (50 percent of walls) are designed for faster renovations, reducing vacancy times.

D **Utilities** wired through flexible baseboards — instead of being embedded into walls — enable flexible walls to be moved or removed with far less demolition work.

E **Retractable facades** open to the outdoors for all-season programming.

F Building **Raincoats** protect sidewalks adjacent to stoa spaces in from rain or snow.

G **Movable kiosks** can be easily moved outside for a livelier market experience.

H **Exposed timber walls** support the greater integration of nature into the urban environment.

I **Modular ceiling grids,** with lighting and AV plug-ins, further support accelerated renovation.

See the “Buildings and Housing” chapter of Volume 2, on Page 202, for more details on adaptable buildings.

To address this challenge, stoa would be built with a flexible interior to easily allow for a wide array of reconfigurations. The structural bones of stoa would consist of an open floor plate with high ceiling height and spacious column bays, offering a shell in which tenants can experiment with a variety of layouts and store concepts using a new system of flexible interior walls. Designed with “plug and play” utility connections that make mechanical, plumbing, and electrical systems far more versatile, these walls would enable operators to safely renovate interiors much faster than usual. In addition, the ceiling would host a modular grid that would allow for easy lighting and audio-visual customization. The finishings could be warm and neutral — for example, a polished concrete floor and an exposed timber structure — providing a durable framework for each tenant’s fit out.

At key locations, the stoa would have double-height ceilings and retractable facades that could be opened to the outdoors, enabling them to be populated with stalls that could be moved outside to act as kiosks for a true market experience.

In practice, these features mean that the stoa could, with relatively minimal intervention, support uses ranging from a grocery store with broad aisles to a small network of art studios. Similarly, a 10-person startup could rent out a small, shared temporary space within the stoa, then take over larger and larger spaces as it balloons to 100 people, rather than having to endure the cost of relocating.

Of course, some fit-outs — like creating a commercial kitchen, which requires unique servicing — would still be challenging. But Sidewalk Labs estimates that costs associated with structural and mechanical elements of renovation, such as moving walls and electrical wiring, would decline by roughly 50 percent. So if it would typically take a landlord $40 per square foot to conduct these aspects of a renovation, it would instead only take $20 per square foot.

In addition, tenants who choose to take full advantage of Sidewalk Labs’ prefabricated components and finishings could reap additional cost savings.

Stoa can support a range of uses, from a grocery store with broad aisles to a small network of art studios.

Enabling an all-day ground floor

Stoa's flexible physical and digital infrastructure enables ground-floor space to evolve over time: from day to night, across seasons, and over long-term economic cycles.

Day to night.
Traditional ground-floor spaces are leased and designed by an individual tenant. If that tenant chooses to stay open just for five hours at night, street life suffers for the rest of the day. Many developers and planners strive for roughly 18 hours of street life, but they struggle to find tenants to help them realize this ambition.

Retractable facades enable stoa to be open-air in warmer months.

A fleet of startups are starting to show how tenants with different peak hours can more effectively share spaces. In Toronto, Flexday converts restaurants into co-working spaces during the morning and early afternoon, before dinner prep commences.[46]

Sidewalk Labs proposes to make this type of sharing easier through a digital leasing and operations service (see Page 164), which would help to co-locate symbiotic businesses or organizations that have different service hours, such as a retail space and a coffee shop.

Season to season.
Business demand and community needs often fluctuate seasonally.[47] Large, garage door-style systems in some stoa spaces would make it easy to move stalls out into open spaces, helping tenants stay active over the course of the year, and blend into bustling street life.

Along these indoor-outdoor spaces, retractable canopies and deployable building "Raincoats" attached to facades would enable stoa to be open-air in warmer months (see Page 170 for more details). In cooler months, building Raincoats would help protect stoa from rain, snow, and wind, in response to real-time weather data. These weather-protection capabilities would make it easy for stoa spaces to change uses to fit the temperature. For example, the stoa could play host to an open-air cinema during the summer and close off to become a space for students to study in the winter.

Long-term.
While buildings can be built to last centuries, the industries and uses that dominate the ground floor tend to shift over decade-long cycles. The rise of e-commerce is accelerating these natural fluctuations, even transforming sectors that are typically known for their stability, like grocery.[48] In today's on-demand world, brands and up-and-coming retailers want flexibility — a brick-and-mortar arrangement as easy to adjust as a website.[49]

Stoa can go where the economy is headed. For example, as stores become less about on-site purchases and more about experience, retailers might opt to ship more items directly from an off-site warehouse to customers' homes. In this scenario, a stoa retail tenant could start with a business-as-usual amount of inventory in store, and scale it back as the store moves towards this new model of commerce.

Similarly, as self-driving vehicles become more common, a two-storey ground-floor car dealership could shrink down to a one-storey showroom, and eventually down to a micro stall for on-demand rentals.

Sidewalk Labs estimates that costs associated with renovation, such as moving walls and electrical wiring, would decline by roughly 50 percent.

How stoa enables multiple uses across the same day

The flexibility of the space makes it possible for a morning flower shop to become an evening jazz club.

A flower shop could stay open from 9 a.m. to 5 p.m., before closing to receive a nighttime jazz club.

When the flower market closes, it could go through a quick clean-up and furniture could be shifted around to prepare for opening as a jazz club in the evening.

This same stoa space could be occupied by a jazz club from 7 p.m. to midnight.

Helping businesses open and grow with a digital platform

Ground-floor tenants increasingly want their physical sites to be as easy to open and evolve as their digital sites. Stoa's structural shell provides a baseline of flexibility. Another key innovation is a digital leasing and operations platform — a concept Sidewalk Labs is calling Seed Space — which would provide services that make it easier for businesses to establish a physical presence, and test out new store concepts in Quayside.

Today, there are lots of barriers to opening up a new physical retail footprint, especially for first timers. In Toronto, a typical commercial lease ranges from five to 10 years, and landlords often do not want to take on the risk of a short-term (or uncredited) tenant.[50] From the tenant perspective, opening a business requires not only locating the right space, but also having the capital to pay for it, finding staff to do everything from check-out to cleaning, and doing enough market research to make smart decisions on questions like branding and hours.[51]

These challenges are magnified for young businesses, like mom-and-pop startups that add character and opportunity to a neighbourhood, as well as online businesses that may want to try out a physical presence without a long-term commitment. But they also affect more established retailers each time they open a new storefront.

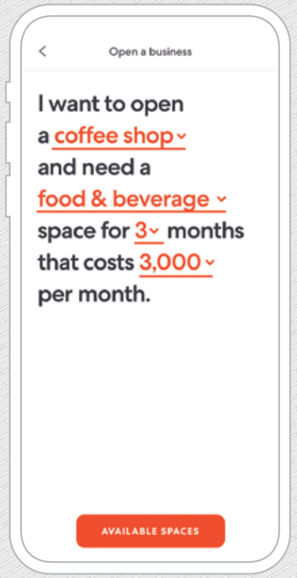
Companies such as Appear Here, Storefront, and Toronto-based UpperCase are helping to de-risk brick and mortar for emerging retailers by providing shorter-term space commitments, and, in some cases, starting to offer fit-out services and even ongoing operational support. They are also de-risking these shorter-term spaces by creating online marketplaces that can match property owners to a ready population of potential tenants from around the world.

In Quayside, Sidewalk Labs plans to build on these best-in-class concepts, offering a suite of services ranging from on-demand leasing to help with permitting to opt-in customer analytics.

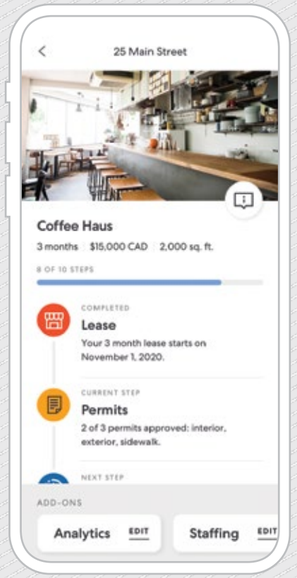
These tools — which are intended to supplement, not replace, brokers — can help tenants by moving some of the big, upfront costs that are normally associated with real estate into more manageable variable costs. For landlords, these innovations provide a marketplace, and reduce short-term space vacancies and downtime between leases. Seed Space services would make it possible for neighbourhoods to keep the street more active, and for landlords to take risks on more dynamic tenants, who might not be equipped or willing to sign up for a five- or 10-year contract.

Innovation spotlight

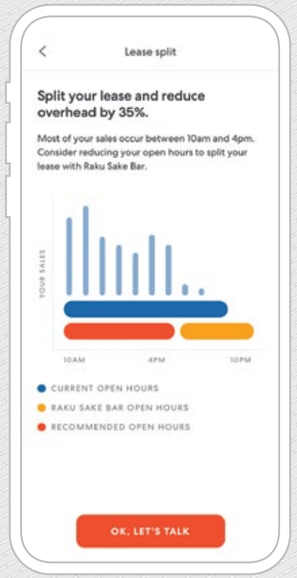
How Seed Space empowers businesses



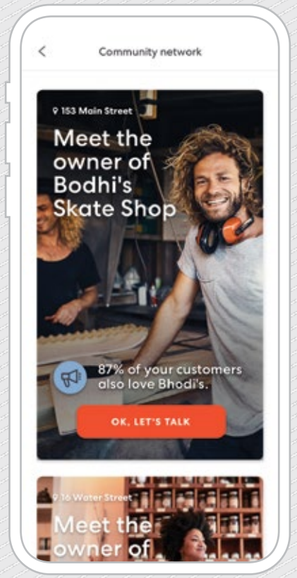
Flexible leases.
Flexible lease terms and tailored space recommendations would break down barriers to entry and open pathways to low-risk explorations.



Guided process.
A guided and expedited process would offer full transparency of the necessary steps, with expertise to support planning and management for a space.



Performance tips.
Adaptable spaces and leases would help merchants maximize space utilization while fostering joint ventures.



Merchant collectives.
A nurtured network of merchants could bond and unite for better business and neighbour experiences.

Committing to a diversity of businesses

It is important that businesses of all sizes — and entrepreneurs from underrepresented backgrounds — have the opportunity to partake in the growth process enabled by stoa's flexible structure and the Seed Space platform. Sidewalk Labs plans to ensure this diversity in two ways: an incubator program, and shared equipment and facilities for ground-floor tenants.

1

Small business incubator.

In Quayside, Sidewalk Labs plans to sponsor a small business incubator designed to help those without access to capital open up shop. A pilot of this effort took place during summer of 2018 at Sidewalk Labs' main Toronto office, 307. Sidewalk Labs hosted new Canadian food entrepreneurs who had previously launched their first retail business with support from the Scadding Court Community Centre at Market 707, on the corner of Dundas and Bathurst.[52]

Sidewalk Labs plans to issue a Request for Proposal for partners to help launch and operate this incubator program. That partner would help source, vet, and provide requisite training to entrepreneurs. In turn, as part of the incubator, Sidewalk Labs would reserve a portion of stalls at below-market rents, enabling the cohort to test ideas and sharpen business skills in a low-risk environment.

2

Shared ground-floor facilities.

In Quayside, Sidewalk Labs also plans to leverage shared equipment and facilities to help local makers thrive in three priority sectors: public food markets, experiential arts, and production uses.

To encourage public food markets to participate in the open stoa concept, vendors would have access to a shared commercial kitchen, allowing them to cook food on-site. To encourage the arts, creatives would have access to shared fabrication and digital tools in the Civic and Cultural Assembly, along with affordable spaces to produce and present works, drawing on the tremendous talent in Toronto, including those who have graduated from Artscape Daniels Launchpad, a short walk away at 130 Queens Quay East. And to encourage production uses, stoa would provide shared fabrication equipment and create opportunities for crossover between production and other industries — be it retail, arts and culture, or food and beverage.

Goal 2

Making Open Space
More Usable More of the Time

Design an outdoor comfort system for all seasons

Even when the conditions are right to promote a vibrant ground floor, the weather plays a big role in determining how much time people spend outdoors. While the seasons drive the character of public life in Toronto — from summer day trips to the Islands, to fall pumpkin parades across the city — it is no secret that outdoor activity is concentrated in the six-month period from late April through October, when the weather is pleasant.

For centuries, cities have used architecture to moderate the weather and keep public life active on the street. In the late 1800s, as historical photographs show, Toronto was filled with a maze of awnings that extended from storefronts and glass arcades to cover alleyways, providing protection from the sun, snow, and rain.

This approach of mitigating outdoor weather changed in the 20th century, as technologies like central heating and air-conditioning shifted activity indoors to climate-controlled, sealed environments. In Toronto, from November through April, the underground PATH network is the centre of gravity for commuting, and the home is the centre of gravity for social activity. Popular outdoor hangouts like Queen West and Trinity Bellwoods quiet down.

That effect is particularly noticeable on the waterfront, which is uniquely exposed to chilly winds. Using climate data collected at Billy Bishop Airport and a standard metric called the Universal Thermal Climate Index, Sidewalk Labs calculated that the waterfront is only comfortable, on average, for 30 percent of the year. The rest of the year is either too hot (29 percent), too cold (37 percent), or too wet (4 percent).[53]

Toronto's waterfront does not have to hibernate, because the capabilities exist to help streets and outdoor space retain their vitality year round. After analyzing climate data and studying how it impacts street grids and buildings, Sidewalk Labs has developed a replicable system of weather-mitigation tools and architectural interventions that could help dramatically increase outdoor comfort. This system would leverage the latest advances in lightweight material technology, and could respond in real time to changing weather.

Systematically applied in Quayside, this approach to weather mitigation would increase the hours it is comfortable to be outdoors by 35 percent, drawing more people into public spaces, together.

Implemented at the full scale of the IDEA District, this approach could go even further, potentially doubling the number of hours it is comfortable to be outdoors each year for key spaces.[54]

Weather-mitigation tools create 572 more comfortable hours outdoors

Figure 1.
Typical development: Comfortable hours outdoors

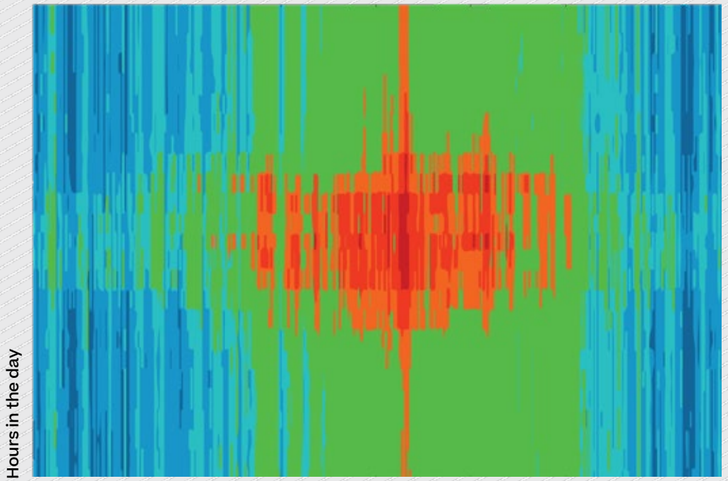


Figure 2.
Sidewalk Labs: Comfortable hours outdoors

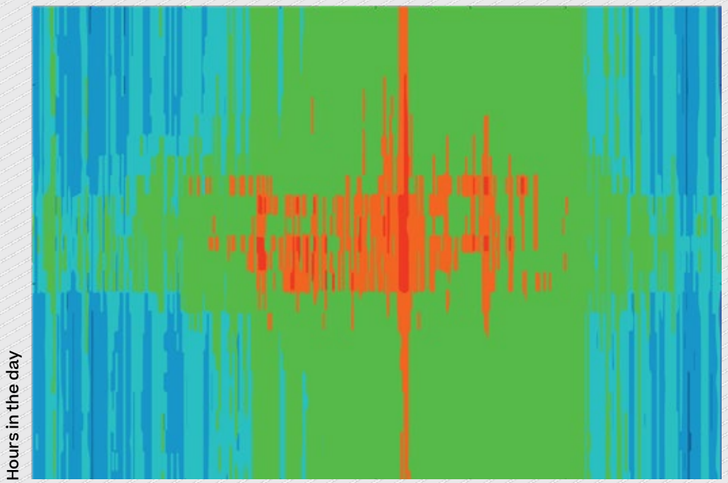


Figure 1 shows baseline outdoor comfort levels for Quayside, based on the Universal Thermal Climate Index. Red areas indicate times when it is uncomfortable to be outside because it is too hot, blue areas show when it is too cold. Green represents times that are comfortable. Because microclimates are complex and dynamic, this methodology focuses on improving comfort in key locations within a neighbourhood, such as pedestrian walkways, plazas, and parks. The metrics in this chart refer to these locations.

Figure 2 shows outdoor comfort levels for Quayside with planned outdoor comfort interventions applied to the neighbourhood site plan. Relative to a typical development on the waterfront, which is comfortable outdoors for 1,653 daylight hours per year, Sidewalk Labs' proposed suite of weather-mitigation tools would make Quayside comfortable for 2,225 hours — an increase of 572 hours, or 35 percent.[55]

Key

- Very strong heat stress
- Strong heat stress
- Moderate heat stress
- No thermal stress
- Slight cold stress
- Moderate cold stress
- Strong cold stress

This increase would be possible thanks to the impact of optimizing the street grid and building massings over a large area. And because the system's core components are modular, it could be replicated in other areas of the city — or adjusted to different climates in other parts of the world.

Partnering to develop a data-driven design approach

Designing for outdoor comfort requires studying an area's "microclimate." Microclimate refers to the weather patterns of a very specific geography. In an urban context, that could be down to the level of an individual street or plaza. It looks at factors like sunshine, temperature, humidity, precipitation, and wind chill — all of which are measured on the Universal Thermal Climate Index.

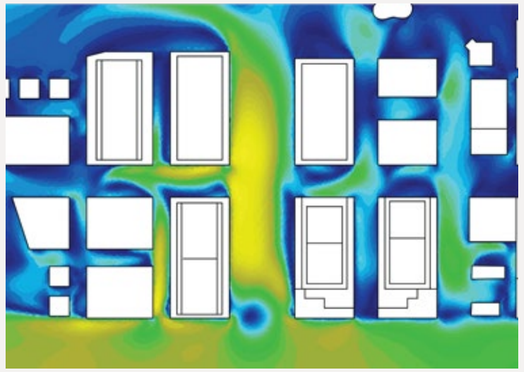
Precision is important when it comes to designing for comfort, because every nook of a city has its own conditions. One street might be in the shade and afflicted by a vicious windtunnel, whereas the next might be flooded with daylight and have only a pleasant breeze. The difference between these two spaces stems from planning and architecture choices, not inherent qualities of weather patterns.

To create a system that proactively predicts and plans for outdoor comfort, Sidewalk Labs worked in close collaboration with multiple partners. RWDI, a team of Toronto-based climate engineers, ran climate analyses for Quayside and the full IDEA District. They collaborated with PARTISANS, a Toronto architecture firm with expertise in new materials and tensile structures, to help iterate on architectural interventions in response to climate data.

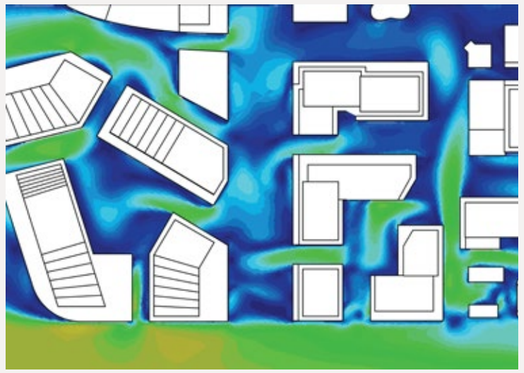
The first step in this joint exercise was to look at the street grid and building masses, and tailor each for wind protection and optimized solar gain. For example, on Cherry Street, adjusting the building facade reduced wind speeds by an average of 35 to 45 percent, and up to 80 percent in certain areas.[56]

Villiers Island: Adjustments to massing can reduce wind speeds and increase outdoor comfort

Precinct plan:
Villiers massing and wind speed



Sidewalk Labs-adjusted:
Villiers massing and wind speed



At Cherry Street, creating slanted building facades reduces wind speed. In the top diagram, the yellow areas represent wind tunnels; in the bottom diagram, those tunnels have been eliminated through the facade adjustment.

Key

- High winds (~4+ m/s)
- Moderate winds (~2-4 m/s)
- Low winds (~0-2 m/s)

(Wind velocity in metres per second)

Creating a core set of weather interventions: Raincoat, Fanshell, Lantern Forest

Next, to achieve an even higher level of comfort, the partners developed a toolkit to address microclimates in and around common urban environments planned for the waterfront. Three prototypical architectural interventions formed an initial set of tools that designers could adapt and recombine to meet the outdoor comfort targets of a specific site: a Raincoat for the building's edge, a Fanshell for open spaces, and a Lantern Forest for urban canyons (spaces between buildings).

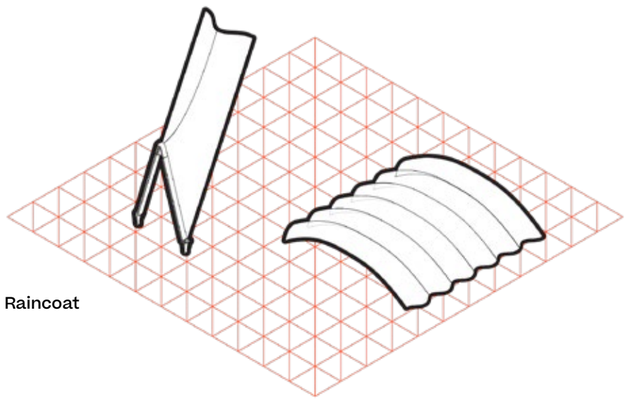
For the Sidewalk Toronto project, these interventions could be installed, managed, and secured through the joint efforts of the ground-floor operator and the Open Space Alliance, a new public realm non-profit entity described on Page 178.

Sidewalk Labs is currently testing these interventions through full-scale prototypes at its Toronto office, 307, which will provide a baseline to evaluate fabrication, installation, maintenance, durability, and comfort performance over the coming months. Design and fabrication partners will provide input on the structure, materials, and costing, and RWDI will measure the comfort performance through the collection of meteorological data around the prototypes.

Sidewalk Labs plans to work with local regulators to ensure AODA compliance for these systems, building on best practices for indicating low clearance zones with tactile cues, and to gain support for pilots in areas where a system (such as the Raincoat) would extend into the right of way.

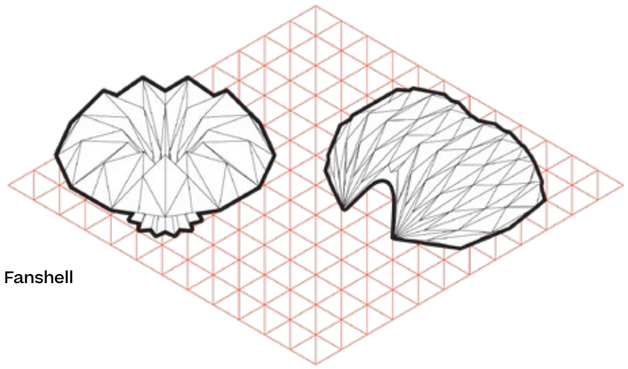
The outdoor comfort system would leverage the latest advances in lightweight material technology, and could respond in real time to changing weather.

The Raincoat extends a building's edge to protect the sidewalk from rain, wind, and sun.



Raincoat

The Raincoat consists of an adjustable awning or "second skin" that could extend outward from a building's edge to protect the sidewalk from rain, wind, and sun. It could attach to one side of a building and anchor into piles beneath the street pavers, or it could be applied as a retractable canopy, spanning from building to building. In that sense, the Raincoat follows the grand tradition of shop awnings, fixed arcades, colonnades, and other installations that help integrate street life into the ground floor of buildings — albeit with a greater capacity to adjust to outdoor conditions. Unlike awnings, the Raincoat is able to more effectively block wind, and change its transparency to allow in more sunlight on cold days and less on warm days.

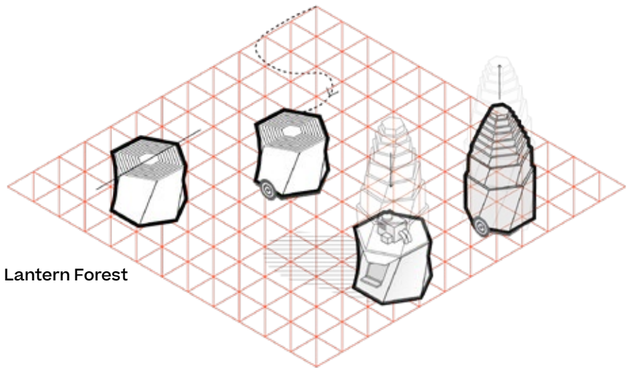


Fanshell

The Fanshell is a collection of large, temporary urban shelters that could provide outdoor comfort in open spaces, such as Silo Park. The system includes two distinct shelter types: the Shell type, a more enclosed system that protects from wind, rain, and sun, and the Fan type, a more open, umbrella-like covering that protects from sun and rain. Both types cover 80 square metres, can accommodate free-standing heaters, and have the capacity to shelter up to 100 people. Both types also employ an origami-style folded fabric construction, which allows them to achieve wide spans, deploy easily and quickly, and be packed flat and stored more easily than a tent.

The Fanshell provides open-space coverage for up to 100 people.

The Lantern Forest mitigates wind tunnels that form between buildings.



Lantern Forest

The Lantern Forest represents a collection of lightweight, tall, narrow structures that could create shelter from wind when grouped together on the ground (almost like a stand of trees), or when hung together from buildings (like paper lanterns). The Lantern Forest would help address the challenge of wind tunnels that form in the spaces between buildings, often called urban canyons. The structures, which could reach eight metres tall, could be useful in many different conditions: a few Lanterns could be placed along lanes, alleyways, and streets; a flock of Lanterns could be placed in larger open areas. The inside could be inhabited by a few people at once in a variety of ways, from kiosks for vendors to warming stations, and could be secured or collapsed during off hours.

ETFE is a lightweight plastic building material that can adjust its transparency in response to weather patterns. It is becoming increasingly popular for entertainment venues, such as The Shed at Hudson Yards in New York City, which opened in April 2019. Credit: Brett Beyer

Materials.

Across the outdoor comfort system, Sidewalk Labs plans to leverage the building material Composite ETFE (Ethylene Tetrafluoroethylene), a durable, highly transparent, lightweight plastic film. ETFE provides transparency without the heavy and expensive structure required to support glass, and is uniquely customizable through printed patterns that can control light and opacity.[57]

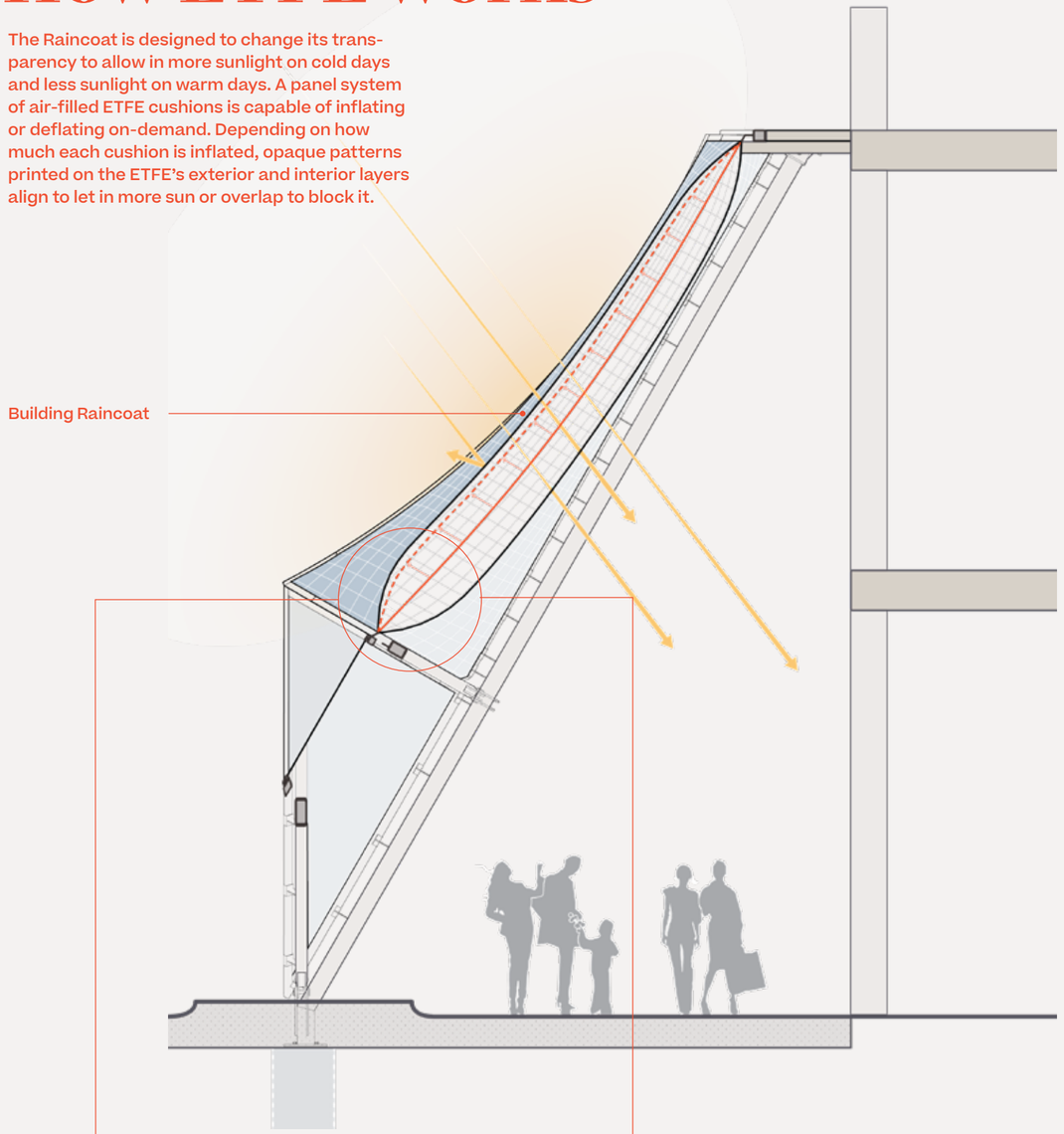
ETFE gained popularity as a building material around the turn of the 21st century, and it is now commonly used in venues like sports and entertainment stadia. As its use increased, a panel system of air-filled ETFE cushions was developed to improve energy performance.
Each cushion is capable of inflating or deflating on-demand. Depending on how much the cushion is inflated, opaque patterns printed on the film layers align to let in more sun or overlap to block it.

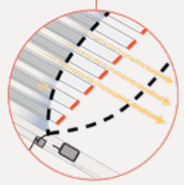
Today, ETFE panels are often applied on one-off projects — such as The Shed in New York City — but they are rarely used systematically as a building material across a neighbourhood. To Sidewalk Labs' knowledge, the Raincoat prototype at 307 is the first use of ETFE as a building material in Ontario.

Sidewalk Labs estimates that maturing the raincoat technology and installing Raincoats at multiple locations within Quayside would lead to a 71 percent cost reduction per installation (relative to the prototype). There should be an even greater drop in expenses per square foot at the scale of the full IDEA District. This scale also affords a great opportunity to explore diverse architectural expressions.

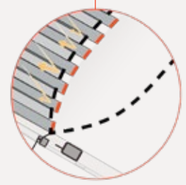
How ETFE works

The Raincoat is designed to change its transparency to allow in more sunlight on cold days and less sunlight on warm days. A panel system of air-filled ETFE cushions is capable of inflating or deflating on-demand. Depending on how much each cushion is inflated, opaque patterns printed on the ETFE's exterior and interior layers align to let in more sun or overlap to block it.





Scenario 1:
Opaque patterns printed on the exterior (shown in blue) and interior (in red) layers of ETFE film are aligned, allowing more sunlight to pass through.



Scenario 2:
As the pressure in the air cushion is adjusted, the internal layer (in red) shifts to cover more surface area and therefore block sun with its opaque pattern.

Environmental sensing.

Another key feature of the outdoor comfort system is an embedded network of microclimate measurement instruments, including wind anemometers, thermometers, and sunlight and rain detectors.

Many of these (non-personal) sensors have dropped dramatically in price over the last 10 years, and can now share information digitally rather than through cumbersome manual transfers.[58] While a wind anemometer may not seem innovative, the integration of many local sensors with a predictive and responsive weather-mitigation system is new.

To ensure real-time deployment, these sensors would gather daily data at key distribution points, such as on building rooftops and around Raincoat canopies, and would be capable of communicating live with the comfort system — for example, telling a set of Raincoat canopies to open in advance of rain, or providing instructions for the placement of Lanterns in response to wind patterns. This network could be further enhanced with computational weather-prediction systems to provide an extra layer of resilience and climate responsiveness to neighbourhoods and cities. The ground floor operator could use this data to make decisions regarding frequency of Raincoat deployment, and the Open Space Alliance could play a similar role for Fanshells and Lanterns.

For more on the proposed use of data in public spaces, see the "Digital Innovation" chapter of Volume 2, on Page 374.

Deployment.

Each structure in the outdoor comfort system intervention would be light and collapsible. The structures would all be capable of attaching to building facades or plugging into power and data outlets located at grade or on buildings. These features create a system that could be quickly deployed, moved, taken down, and stored. As kinetic technologies and autonomous delivery systems evolve, Sidewalk Labs anticipates that the set-up, take-down, and delivery of these structures could become increasingly automated.

For example, each Lantern would include a mobile base that could serve as a kiosk — similar to those used by street vendors today — as well as a roof structure that could expand to provide wind protection. The roof structures could be placed atop each kiosk, collapsed when the kiosk is moved or stored, and extended upwards to create progressively larger wind breaks when the kiosks are deployed. Alternatively, the Lantern roofs could be hung between two buildings on a catenary wire (included in the design of the street), keeping the ground free until their programing is needed. Some Lanterns could be leased by vendors, while others could be requested for special events.

Weather-mitigation tools can increase comfortable hours by at least

35%

annually in Quayside.

Scaling.

The outdoor comfort system's modularity would enable it to accommodate a wide range of community activities and needs.

For example, the Fanshell system is designed to provide large urban canopies that could be reserved and used for things like social events, art installations, and cultural gatherings. The coverage that each Fanshell provides could grow by placing additional Fanshells side-by-side: one Fanshell might be enough to provide shade for a family barbecue, while multiple Fanshells might help an arts organization put on a festival during a rainy spring day. Reservations and requests could be managed through a digital booking system, and two-to-four trained installers could deploy each Fanshell in a matter of hours — making this system much more agile than current rental tents, which require a large crew for setup sometimes a day or more in advance.[59]

Adaptability.

Each aspect of the system features adaptable materials and components that would respond to microclimate data in different ways.

For example, the Raincoat's ETFE panels have a sensitive exterior cushion that could respond to sunlight by inflating (creating more shade) or deflating (letting in more light). This adaptability would help the Raincoat protect ground-floor space from summer heat; it also would enable the system to transition easily between daytime and nighttime activities, as temperatures and light patterns change. Furthermore, the Raincoat could cover plazas and narrow streets, providing on-demand shelter for pedestrians.

Cost-Benefit.

The cost to build this outdoor comfort toolkit ranges from $500 to $2,100 per square metre, depending on the module.[60] Sidewalk Labs expects further cost declines as technology advances and the markets for new materials grow. The price of ETFE has already dropped significantly in the past decade, as it is used in solar panels and has benefited from economies of scale related to the growth of the renewable energy industry.[61]

Such costs can be justified when weighed against the increase in usable hours of public space. A study done at MIT showed that people were twice as likely to eat lunch in a public courtyard, and stay outdoors for longer, during weather that was comfortable according to the Universal Thermal Climate Index.[62] When more people are comfortable going out, restaurants, stores, and services see more business, offsetting build and operating costs with increased economic activity. Economic activity is known to drop during winter months throughout Canada, with retail sales falling up to 20 percent.[63]

Based on climate modelling of the outdoor comfort system in Quayside, Sidewalk Labs anticipates an increase in comfortable hours of 35 percent annually. While it is hard to determine the exact impact of more comfortable days on economic activity, it is reasonable to assume at least an incremental increase in spending derived by making outdoor spaces, streets, and shopping areas more comfortable.

Ch–2

Part 3

Ensuring Open Space Is More Responsive

Key Goals

1
Establish an entity to coordinate programming, operations, and maintenance

2
Provide physical infrastructure that enables community programming

3
Provide digital infrastructure that enables proactive maintenance

4
Connect urban innovators and public spaces

Public spaces typically look fantastic on opening day. Local leaders rally around a ribbon-cutting, inaugurating a space with freshly cut grass, shiny new play equipment, and perhaps a sports field serving a new rec league. But the excitement of Day One aside, the most successful public spaces continuously respond to how people want to use the space, and its ongoing operational and maintenance needs.

In great public spaces, planners, workers, and users are all in sync. The community adopts the space as their own, filling it with programming, and volunteering to help with tasks like raking leaves. But when these groups are misaligned, public spaces can fall into disrepair. In 2017, the Center for Active Design conducted a large-scale quantitative study, which found that it was actually better for a neighbourhood's civic life to have no green space than green space that is poorly maintained.[64]

Sidewalk Labs proposes to build a public realm that is more responsive by establishing a non-profit entity called the Open Space Alliance (OSA), which would focus on delivering local programming, operations, and maintenance, working in close concert with the community and leveraging new technology. In partnership with the City of Toronto, the OSA would create opportunities to pilot ideas together with city staff, enabling a continuous cycle of knowledge sharing and learning to help successful innovations benefit Torontonians around the city.

The proposed OSA would administer shared physical infrastructure that could help people shape and program shared spaces, as well as digital infrastructure that could proactively address operational and maintenance needs. The proposed entity could also help urban innovators, ranging from civic technologists to startups, run pilots in open space, advancing the urban innovation economy in Quayside and turning Toronto into a global leader in public realm management.

Goal 1

Establish an entity to coordinate programming, operations, and maintenance

The idea for the Open Space Alliance to play a central coordination function across programming, operations, and maintenance stems from a few trends visible across cities, including Toronto.

Cities typically try to create an integrated open space experience across a neighbourhood, but face the reality that open spaces are owned or managed by a medley of different entities, from private developers to the parks department to transportation agencies. Coordination across these groups is often difficult, and when they are not in sync it can lead to disjointed programming and maintenance standards, creating a suboptimal experience for residents, workers, and visitors.

Additionally, cities want to explore how technology can improve open space programming, operations, and maintenance, but existing structures do not allow for easy experimentation. Technology development cycles require rapid prototyping, but most cities lack the processes to conduct fast pilots around new software like digital permitting processes, or new hardware like automated trash removal.

Lastly, cities want to maintain a high-quality open-space network, but face chronic funding shortages. In Toronto, the city's parks budget has grown only $8 million in the past four years — an amount that has not kept pace with inflation — despite the opening of many new parks.[65] The limited funds that are available are generally focused on daily upkeep, making it challenging to cover the types of temporary arts and cultural programming that bring a space to life.

In Quayside, along with other areas of the IDEA District, management and funding disparities risk becoming even more pronounced, as self-driving vehicles create the opportunity to expand pedestrian areas by up to 91 percent and create new open spaces. These new spaces, which occur in former vehicular rights-of-way, would still be owned by the city and managed by its transportation department, but would now be operated more like parks. These spaces would need to be effectively integrated with the local park network and would benefit from comparable levels of management and funding.

For Quayside and other areas of the IDEA District, Sidewalk Labs proposes the OSA as a public-private partnership, jointly governed and financed by both sectors, to help address these challenges. All city-owned open spaces would remain owned by the government, which would participate in programming, operations, and maintenance with the OSA.

Establishing a clear mission and governance principles

Sidewalk Labs proposes that the OSA convene residents, commercial tenants, landowners, and government partners to identify and achieve a clear mission consisting of the following objectives:

Objectives

A Create a dynamic, well-programmed, well-maintained public realm that benefits the community and city.

B Create a seamless public realm experience that establishes a unique sense of place and generates value for the neighbourhood.

C Create the conditions for technology exploration in programming, operations, and maintenance, piloting new approaches that maximize access and enjoyment of shared open space.

D Create a mechanism for operating open space that is viable over the long term, including sustainable funding, and that ensures public-private sector knowledge-sharing.

This type of public-private partnership on open space management is not new in Toronto, although the technology focus is unique to the Sidewalk Toronto project. When developing open spaces with outside entities, including non-profit institutions, the city typically structures "collaborative management agreements" to share programming, operations, and maintenance responsibilities. Such partnerships include Evergreen at the Brick Works, the AGO at Grange Park, Artscape at Wychwood Barns, and the Bentway Conservancy under the Gardiner Expressway. Partnerships also include agreements with Business Improvement Areas, like at the Village of Yorkville Park, where the Bloor-Yorkville BIA supplies maintenance of specialized features and programming. Sidewalk Labs proposes that the OSA take inspiration from these local best-practice examples.

The Bentway is a public space under the Gardiner Expressway. Programming, operations, and maintenance at the Bentway is performed by the Bentway Conservancy, a local non-profit established through a public-private partnership, which was kickstarted by a donation from the Matthews Foundation. Credit: Andrew Francis Wallace via Getty Images

Sidewalk Labs plans to work with the city, Waterfront Toronto, and a local non-profit partner with experience in open space management to develop the details of the non-profit entity. The working group would apply a version of the following governance principles in the design of that entity:

Principles

1 The public realm needs to reflect a truly public space — with the city retaining ownership of city-owned open spaces — while also protecting the needs and rights of private property owners on their land.

2 The day-to-day function of the public realm needs to be as seamless as possible, both to create a better sense of place and to facilitate operational efficiencies.

3 The entity needs to be responsive (through legal agreements, board seats, public transparency, or other means) to both government and private landowners.

4 The entity needs to be structured to support creative experimentation in all facets of its operations, taking advantage of the physical and digital infrastructure in Quayside.

For more on the proposed use of data in public spaces, see the "Digital Innovation" chapter of Volume 2, on Page 374.

While the proposed OSA would have the capacity to perform programming, operations, and maintenance services, where and how it delivers these services would depend on agreements with individual landowners, including private landowners, and local land-holding government agencies. The OSA would also be informed by the needs of the community, who would have representation in the entity's decision making.

The OSA would not have its own product development arm. Instead, as proposed, it would manage the physical and digital infrastructure that Sidewalk Labs plans to deliver, and it would have funds in its annual operating budget to procure technology services that could help improve programming, operations, and maintenance. In addition, its budget would include funds to support technology-enabled arts and cultural programing, such as artist residencies. Generally, the OSA should be set up to facilitate the ideas of others who want to activate and improve open space, rather than act as a top-down planning body.

Like all other technologies proposed for the IDEA District, all projects or pilots involving urban data would have to follow the proposed Responsible Data Use Guidelines, and be subject to the oversight of the proposed Urban Data Trust.

Goal 2

Ensuring Open Space
Is More Responsive

Provide physical infrastructure that enables community programming

The most vibrant public spaces are the ones in which people have a role in their creation. Toronto knows that well, whether through the community group that organizes Tai Chi in Yonge Dundas Square, Scadding Court's transformation of a defunct Target in Hamilton into a community centre, the families that rally to convert their block in the Annex into a play street, and so many others.

In all of these examples, a small group of passionate people banded together with an idea, and jumped through hoops to make that idea a reality. To build that type of participatory ability into a neighbourhood's foundation, Sidewalk Labs plans to deliver shared physical infrastructure that the community could program and a tool to help communities measure the impact of those efforts.

In Quayside and across the greater geography of the IDEA District, these initiatives would empower the community to turn its needs and ideas into reality, democratizing placemaking across public spaces. The aforementioned 2017 Center for Active Design study found that people who report access to an abundance of community events say that they interact more with their neighbours (up 10 percent); that they work more with others for change (up 11 percent); and that they attend a greater number of events in their neighbourhood (up 22 percent).[66] Shared infrastructure enables an abundance of diverse, new, community-driven programs, resulting in people spending more time outdoors, together.

The 2017 Center for Active Design study found that more community events foster up to

10%

more interactions with neighbours.

Creating the conditions for community-led programming

In Quayside, Sidewalk Labs plans to build shared, adaptable programming infrastructure into the foundation of the neighbourhood, creating the necessary groundwork for affordable experimentation.

The community would be encouraged to take a leading role in programming its own spaces, supported by diverse types of infrastructure built into the environment to make a broad range of visions possible. Open spaces would be equipped with infrastructure such as projection screens, universal mounts, and utility hook-ups, which people could easily access to bring their vision to life — whether it be an immersive art show or a pop-up food market.

Community members would be able to access this infrastructure for their own programming purposes through the OSA. Shared physical infrastructure could also be complemented by civic engagement tools that enable community members to express their preferences for events that take place in shared spaces.

This kind of shared physical infrastructure could enable any number of ideas for community programming and neighbourhood improvement:

Play.
A teenager could join a virtual queue to play a life-size chess game projected onto the side of a building. The next day, the projected game could be Chinese checkers, and an elderly resident might sign up. Crowds could gather to watch the game in action.

Arts.
A local arts collective could be chosen to set up an installation in Parliament Plaza. They would be able to affix various components of their installation to the buildings and use the power conduits to operate a moving display. They could also use the proposed public Wi-Fi network to run an augmented-reality experience that complements the art.

Community.
The leader of a youth dance group could schedule a practice time slot at a park stage. She could request an outdoor-comfort Fanshell to cover the stage in case it rains. She could also control the speakers, which would be programmed to shut off at a certain decibel level.

Nature.
An environmental advocacy group wants to measure air-quality levels. They could receive permission from the Urban Data Trust to hook up (non-personal) air-quality sensors to mounts around Quayside. The data would be transmitted live over the connectivity network and become publicly accessible for others to use as well.

Helping communities measure impact and drive change

Digital tools that make measuring the success of public spaces easier for everyone, from community groups to municipalities, provide yet another way to encourage local participation and programming.

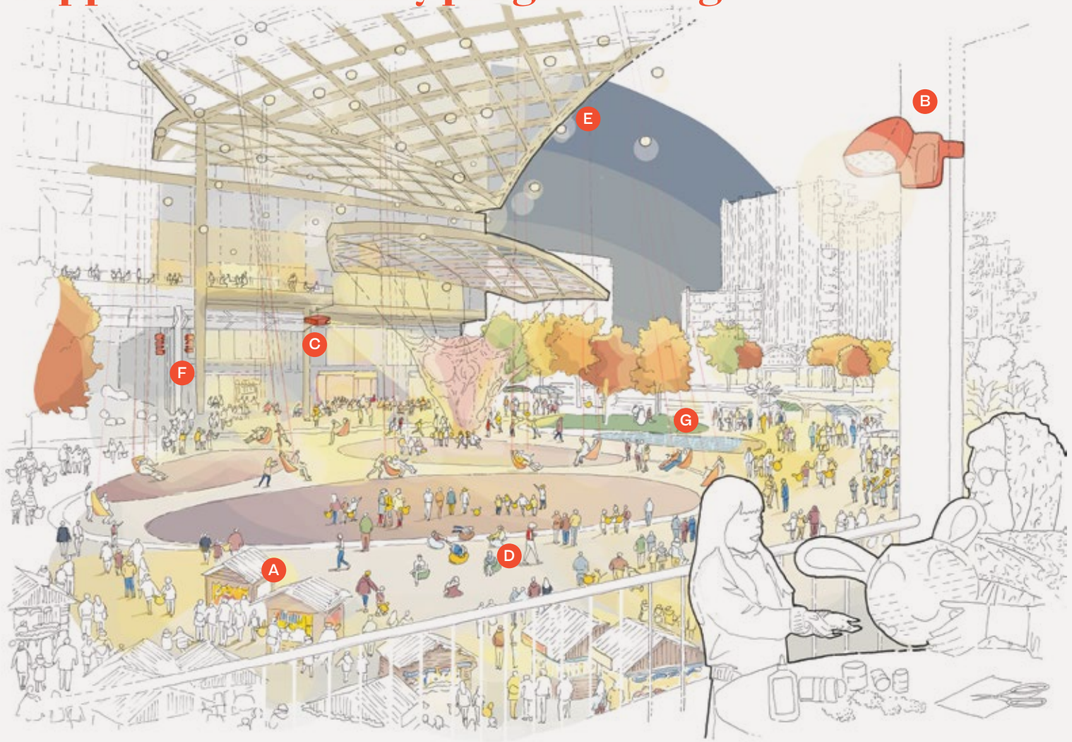
Urbanists have a long tradition of using data to champion the reform of public space. In the 1960s, Jan Gehl's careful documentation of people standing, sitting, waiting, and talking along Strøget, Copenhagen's main thoroughfare, made the case for pedestrianizing the street, helping to transform the city into a global leader for public space.[67] More recently, after conducting public-life studies to inform TOcore, Toronto's new plan for downtown, the City of Toronto has begun to integrate the practice of public-life studies into their public-realm improvement and capital-planning processes.[68]

But the tools used to study public space have changed very little since they were developed in the 1960s. Today, many managers of public space and community advocates still rely on clipboards or manual clickers to count the number of people in a space and classify what they are doing. Given these high barriers to collecting data and insights, managers are left to steer design, programming, and maintenance without full knowledge of what is happening on the ground. And while there are many forms of obtaining community feedback, lack of quantitative information can make it hard to share findings and compare interventions.

To address this problem, Sidewalk Labs developed a digital application called CommonSpace that makes it easier to

Continued on Page 185

Shared physical infrastructure supports community programming



A **Power and conduits.**
Weather-protected outlets, with 220 and 110 voltage capabilities, would be interspersed on stoa and trusses throughout public spaces. They would have ample conduit space to run cable for data, electricity, or another utility. Having power and conduits available throughout the public realm would enable flexible events or installations.

B **Physical mounts.**
Mechanical and electrical connection points located on buildings, light poles, bollards, and other public-realm furniture would enable the installation of new devices and creations on a temporary basis, ranging from lighting to banners to environmental sensors.

C **Projection.**
A series of high-resolution laser projectors with interactive capabilities would be accessible throughout the neighbourhood. These would be mounted to fixed lampposts but have the ability to be repositioned depending on the program. Advanced projection-mapping technology would turn the city into a three-dimensional screen that could be used to show content or for playful artistic creations.

D **Public Wi-Fi.**
Ubiquitous connectivity capabilities would be accessible throughout the waterfront. Public Wi-Fi helps tackle the digital divide and enable new experiences in physical space, such as augmented- or virtual-reality exhibitions.

E **Lighting.**
An LED lighting system throughout the public realm (typically mounted to stoa or light poles) would allow for dynamic adjustment of lighting levels, colours, and moods. This exterior lighting would provide the optimal balance of visibility and comfort, allowing for concerts and other activities to take place in the evening.

F **Sound.**
An array of speakers and public address systems would be deployed throughout the public realm. In some spaces, speakers would be mounted to trusses or stoa; in others, the sound systems would be movable. Speakers and audio systems would enable things like outdoor movie screenings, cultural performances, or intimate audio art installations.

G **Water.**
Controlled applications of potable water would be available in key public spaces, including fountains and service hook-ups at pop-up sites. Not only is water necessary for food and beverage services, but it could also add playfulness to the public realm in the form of mist machines, splash pads, and more.

A volunteer in R.V. Burgess Park uses the CommonSpace app to document activity in the park.

Continued from Page 183

collect reliable data on how people use public spaces. To prototype CommonSpace, Sidewalk Labs has partnered with the non-profit Gehl Institute and a national charity, Park People. The app was field tested as part of Park People's Public Space Incubator Program, an initiative that awards grants to pilot experimental programming in Toronto's public spaces.

With CommonSpace, park operators or community organizers can enter information they observe about public life into a user-friendly app, such as what assets or areas people prefer or what spaces they avoid. The app records data in accordance with the Public Life Data Protocol, an open data standard (published by the Gehl Institute and founding municipal and private partners) that makes it possible to compare public spaces. The data captured with CommonSpace can be easily exported into visualization and analysis tools that communities and space managers alike can use to see patterns, generate insights, and develop evidence-based approaches to advocating for change.

In fall 2018, Sidewalk Labs worked with Park People and the Thorncliffe Park Women's Committee to conduct a field test of CommonSpace in R.V. Burgess Park. The Thorncliffe Park Women's Committee was funded by Park People's Public Space Incubator to further develop the community cafe and market the committee had started in the park. The test concentrated on using CommonSpace to measure how increased programming and better cafe seating changed how people used the space. Local youth and other residents collected data on how many people came to the park and how the new chairs and programming affected what they did there.

The team found that the park saw a massive, 365 percent spike in visitors on programming days, and that the activity was far more social, with large increases in people coming in groups, meeting new people, and staying into the evening. The study not only gathered valuable data that can help the Thorncliffe Park Women's Committee understand and communicate the impact of its efforts, but it also enabled participants to learn about their community while changing how they think about the park.[69]

CommonSpace's code is open-source and based on an open-data standard, so it can be further developed by users in Toronto and around the world to gather the data needed to improve public life in their communities.

Goal 3

Ensuring Open Space
Is More Responsive

Provide digital infrastructure that enables proactive maintenance

The 2017 Center for Active Design study found that community pride drops by

10%

when open spaces are poorly maintained.

Another key to fostering highly active and responsive public spaces is upkeep of operations and maintenance, tasks that can benefit greatly from new technology.

Operations and maintenance are becoming increasingly challenging in cities around the world, including Toronto, as budgets stay flat while infrastructure ages and urban populations grow. The 2016 Canadian Infrastructure Report Card found that public sport and recreation facilities were in worse physical condition than any other asset category, including roads, bridges, and water systems, reflecting lower levels of maintenance and repair spending.[70] Public-space operators responsible for vast portfolios often struggle to keep up with both everyday issues such as overflowing waste bins or broken benches as well as more sudden, severe problems that may arise.

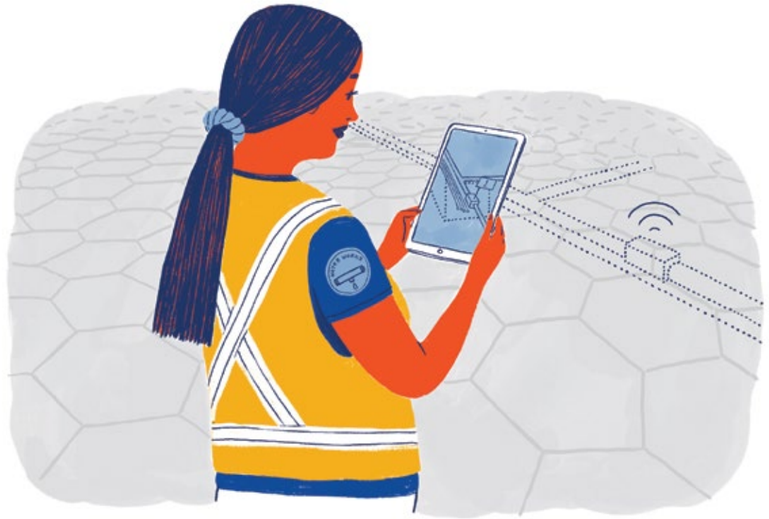
While technology cannot solve budget constraints, it can help cities like Toronto achieve open spaces that work better for everyone. Drawing on new digital capabilities that can make operations and maintenance more responsive, Sidewalk Labs proposes to create a real-time digital map that acts as a centralized repository of information about the conditions of the public realm. This map would leverage environmental (non-personal) sensing to ensure that new issues — from a broken pipe to dehydrated horticulture — are detected and promptly addressed.

Applied in Quayside and across the IDEA District, this digital infrastructure would lay the foundation for public spaces that are better operated and maintained, encouraging people to invest in their neighbourhood and form community bonds. The Center for Active Design has found that people who report high levels of litter have 10 percent less community pride and believe 10 percent less frequently that community members care about one another than those who report low litter levels.[71] Operational and maintenance upkeep creates public spaces that people want to spend time in and work collectively to improve, creating a virtuous cycle that leads to a thriving neighbourhood.

Launching a real-time digital map of open space assets

The popularization of real-time digital maps over the past 15 years has revolutionized the ways people interact with cities — from planning a commute to deciding where to eat. But while live, shared digital maps are now pervasive in many industries, they are still relatively uncommon as a tool for open-space management.

Workers could be alerted to a water pipe pressure change that may indicate a leak. A digital map could show them where the sensor is that triggered the warning, so they know where to target their inspection, preventing the leak from worsening.



Planning drawings are typically static files, with geospatial data manually updated at specific intervals, leading to information that is outdated or inaccurate. The various city entities responsible for managing different aspects of the public realm — such as recreation, landscape, and capital projects — might use different operations software built on separate databases, resulting in difficulty coordinating activities. And the public rarely has access to operations data, precluding people from making decisions based on open-space conditions.

During Quayside's design and construction process, Sidewalk Labs plans to create a high-resolution, 3D, comprehensive digital map of the public realm. This map would serve as a single repository for information about open spaces and related infrastructure, creating a shared foundation for ongoing operations and proactive maintenance by the OSA.

This map would be populated by geospatial data that clearly defines boundaries of spaces and managed assets. It would include all types of public spaces, such as parks, plazas, and public libraries; amenities and physical infrastructure, such as swing sets and benches; and utility systems, such as stormwater pipes, waste systems, and power grids. It would also include the shared participatory infrastructure described on Page 184, such as electrical outlets, Wi-Fi, and media projectors, as well as movable components like picnic tables, chairs, and signs.

The map would be updated continuously through data transmitted by environmental sensors and information provided by open-space managers and users — ensuring it always stays up to date.

Sidewalk Labs proposes that access to the map vary by role. Open-space managers would have a full view of the map and be able to run their operations software on top of it, enabling the integration of complex workflows — for instance, automatically scheduling maintenance staff after a big event. A public visualization would help community members make far more informed decisions about their use of public spaces based on actual conditions — for instance, people could see when construction is scheduled.

Keeping the map updated in real time. To be most useful, a holistic public-realm map needs to stay updated with actionable information. That is where environmental sensing technology comes into play.

Connected infrastructure is increasingly used by cities to monitor conditions and manage the delivery of public services across sprawling jurisdictions. Many cities, including Toronto, have deployed smart water meters that both reduce costs by eliminating the need for manual meter reads and alert property owners and the city to unexpected changes in usage that may signal leaks.

Sensing systems also help level the playing field of information. Research has shown that the propensity to call 311 and report problems differs among socioeconomic and demographic groups in a manner that can exacerbate inequalities.[72] Environmental sensors have the potential to ensure equity in service delivery by identifying needs in a uniform manner.

Sensors also enable predictive maintenance to prevent major infrastructure failures — for instance, by identifying water main breaks that can lead to sinkholes. These tools identify opportunities for proactive repairs that can save hundreds of thousands of dollars.

Digitally monitored utilities. As an example of the power of a real-time map coupled with environmental sensing infrastructure, consider the operation and maintenance of utilities.

Today, the lack of well-organized paper records used to track utilities is a major source of street disruption and project delay. Every time an operator performs work on a utility, someone must check the records to identify any potential conflicts at a work site, many of which are not readily available or were never recorded in the first place. Even when documents are available, it is not uncommon for work crews to hit some long-forgotten water pipe or old power line installed in an unexpected location, halting work so the hazard can be properly reviewed.

A real-time digital map of the utility network — with utility status regularly updated by sensors — has the potential to reduce the incidence of accidental utility strikes and the overall time associated with maintenance. Such a map could keep an accurate, ongoing record of utility conditions and alert work crews of potential conflicts during repairs or installations. It could also reduce by several weeks the time it typically takes to locate underground utilities and research records.

The application of utility sensors goes far beyond facilitating road work. They could help extend the life of infrastructure systems by providing operators with early warnings, such as the systems monitoring the conditions of water pipes that Toronto and many other cities already have in place to prevent leaks. Sidewalk Labs estimates that, in Quayside, a water pipe sensing system could ultimately save up to $200,000 a year in preventing quotidian water leaks, and another $300,000 for each prevented water main break.[73]

More novel applications include the ability to monitor stormwater systems and empty detention tanks before a heavy rain; track temperatures on a thermal grid to maintain the desired range; identify failures in underground freight tunnels or blockages in pneumatic waste collection pipes; and detect street light outages that require bulb replacement, among many other uses that would be helpful for the OSA.

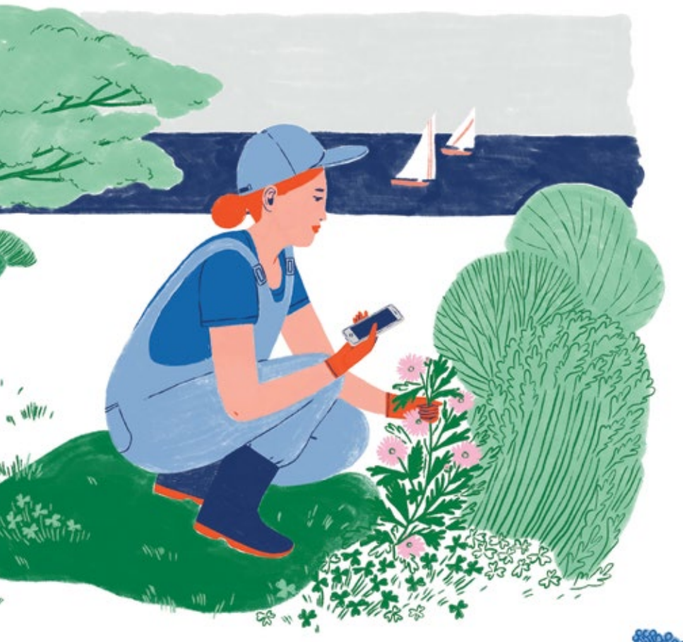
Water pipe sensors could save up to
$200,000 a year
in prevented leaks.

The Open Space Alliance would enable a continuous cycle of knowledge sharing and learning to help successful innovations benefit Torontonians around the city.

Goal 4

Ensuring Open Space
Is More Responsive

Connect urban innovators and public spaces



A maintenance worker uses image recognition to identify a plant and pull up pruning instructions.

The OSA's new policy and funding framework, which encourages experimentation, coupled with the shared physical and digital infrastructure described on Page 184, enables urban innovators, from civic technologists to businesses, to prototype their ideas in a real-world environment. These tools would not only improve the operations and maintenance of open space but would also have the potential to scale elsewhere and help other parts of the city. The following page describes two hypothetical examples.

1

Horticultural maintenance.

Take one common operations challenge: a designer plans a park with a naturalistic landscape and a specialized maintenance regime, but maintenance instructions are not readily available to the workers in the field responsible for pruning. In Quayside, the designer could decide to upload instructions into the digital map during the design and construction phase through the OSA's online portal. With access to the map, the designer could include geo-tagged information spelling out how the naturalistic plantings should be maintained.

After the park opens, a computer science software class could build an app that makes it easy for these instructions to pop up whenever maintenance workers arrive on location. This app could use image recognition to help identify plants as well as pest and disease issues, making it easier for people to keep the garden in a state of good repair without specialized landscaping knowledge. The OSA could agree to instruct their maintenance workers to use the app as part of a pilot.

If the pilot were successful, the team of students could seek venture funding — perhaps from the Urban Innovation Institute, a proposed new venue for practical research on the future of cities — to try to further advance or scale the idea.

See the "Economic Development" chapter of Volume 1 for more details on the Urban Innovation Institute.

2

Waste robots.

Take another challenge: making sure that public trash receptacles are emptied before they overflow.

In Quayside, the OSA could place a call for proposals to launch a self-driving waste pilot program. Startups could bid, and once the selected company's proposal was approved by the Urban Data Trust, in coordination with the OSA, it could place self-driving trash cans throughout the public realm for a testing period. The trash cans could include sensors that detect when each bin is filling up. When a bin became full, it could shut itself and travel to a nearby pneumatic chute, dispose of its contents, and promptly return to its original location. It could then transmit data on waste bin location and refill rates into Quayside's digital map, which the OSA's operators could analyze to make more informed choices regarding where waste bins should go.

If the pilot were successful, the startup would have shown valuable proof of concept in a real world environment, and the OSA would have identified a new system that improves the standard of care for its parks at a lower cost. In turn, such successful technologies could spread back to the rest of Toronto, turning the city into the global leader of open-space management.

Ch–2

Public Engagement

The following summary describes feedback related to the **public realm** and how Sidewalk Labs has responded in its proposed plans.

As part of its public engagement process, members of Sidewalk Labs' planning and innovation teams talked to thousands of Torontonians — including members of the public, expert advisors, civic organizations, and local leaders — about their thoughts, ideas, and needs across a number of topics.

1 Create a sense of belonging through participatory design, accessible amenities, and diverse programming

What we heard

Participants urged Sidewalk Labs to make public spaces as inclusive as possible, no matter a person's background or ability. Participants in co-design sessions noted that all public spaces should be built with people with disabilities in mind and should relay information in multiple modes (haptic, visual, audio). Visitors to 307 wanted to see spaces for diverse cultural practices as well as food stores that cater to diverse cultures. And multiple participants raised the importance of critical amenities, including accessible non-binary washrooms, places for changing diapers or breastfeeding, and affordable retail space.

Participants were particularly enthusiastic about a ground-floor strategy that could provide affordable space for vendors, small businesses, and social enterprises. The experts who attended one workshop on mass timber buildings were similarly enthusiastic about the strategy's potential; however, they urged Sidewalk Labs to consider the governance and management of the space, asking questions like: how would leases or occupancy be ensured, and how would the balance between retail and community use be determined?

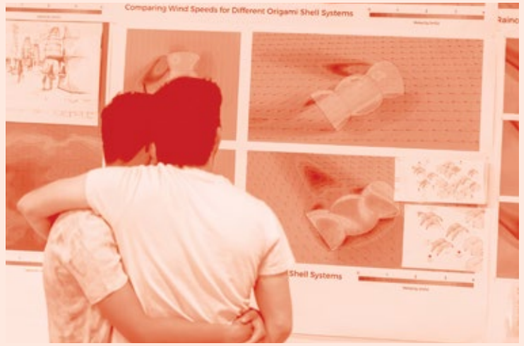
Various participants also recommended that inclusion extend to the design process itself, asking that Sidewalk Labs bring community members, especially Indigenous voices, to the planning table. Design excellence need not sacrifice the accessibility or inclusivity of the public realm.

How we responded

Emphasizing inclusion.
Sidewalk Labs has incorporated an expansive, diverse network of open spaces into the plan for Quayside, and followed design principles focused on inclusive, participatory programming (see Page 178).

Incorporating accessibility.
In keeping with Sidewalk Labs' accessibility principles, all public spaces would incorporate responsive sounds and tactile pavement. Sidewalk Labs plans to continue working with the community to ensure that public spaces are accessible to all (see Page 106).

Making space affordable.
Sidewalk Labs proposes to include adaptable retail spaces, flexible lease terms, options for co-tenancy, and operating tools and services that tenants can use to reduce the upfront and ongoing costs of occupying ground floor spaces. This mix of offerings would make it financially feasible for community, cultural, and smaller businesses to set up shop (see Page 164).



Two visitors embrace as they view RWDI weather-mitigation visuals in the main hall of 307. Credit: Jenna Wakani

Expanding opportunities.
Sidewalk Labs plans to offer a small business incubator program that would encourage diversity by both providing space at below-market rents and offering shared equipment and facilities for ground-floor tenants, helping those without access to capital open up shop (see Page 166).

Engaging Indigenous groups.
The Brook McIlroy Indigenous Design Studio has created a framework for Indigenous engagement and project development — including principles for Indigenous design — based on aspirations of the Indigenous community and the desire for common ground. Sidewalk Labs is committed to continue to engage with these principles and Indigenous communities throughout the planning process.

2 Emphasize connections to nature and water

What we heard

Participants across public engagement events and co-design sessions were incredibly enthusiastic about the potential for plentiful green public spaces that can better connect people to nature, especially water.

Participants from the design jam on "Water Connections" and the Residents Reference Panel were particularly emphatic on this point: water should be both a destination feature and an accessible, everyday amenity. As one panelist explained, "I make great use of the parks around me. … I hope Quayside, and the eastern waterfront, will have that same kind of easy access to park space. There needs to be a reason for people to go there other than to live or work. And Lake Ontario is majestic."

Some visitors to 307 recommended that the public realm design reduce the impact of the Gardiner Expressway and mitigate noise pollution. And Roundtable 4 participants asked about how the community could be more self-sustaining, potentially with urban agriculture, green roofs, and food gardens.

A crowd gathers to hear remarks at the opening of 307 on June 16, 2018. Credit: Sidewalk Labs

How we responded

Expanding green space.
Sidewalk Labs proposes to reclaim significant street space for the public realm and tree plantings by narrowing lanes, reducing vehicle lanes, and eliminating curbside parking. It also proposes to leverage a digital planning tool to identify opportunities for more high-quality parks, maximizing access to green space (see Page 128).

Infusing greenery.
Sidewalk Labs proposes to plant far more greenery than most cities do today. Greenery sequesters carbon, mitigates the urban heat island effect, reduces the risk of flooding, and promotes the health and happiness of residents and workers. For example, the proposed Queens Quay East could host 95 trees per hectare, roughly double the current coverage on boulevards (see Page 135).

Incorporating water features.
Sidewalk Labs proposes that Parliament Plaza include water features, such as a splash pad for children and mist machines for public art installations (see Page 146).

Connecting to the lake.
Sidewalk Labs proposes to deploy a series of barges in Keating Channel designed for community water-based programming across the seasons, from a waterfront classroom to an aquaponics farm to a cafe (see Page 149).

Accommodating marine uses.
Sidewalk Labs proposes that Parliament Slip accommodate a variety of marine uses, from personal watercrafts to water taxis to kayaks, allowing for marine transit to the inner harbour and islands. These uses would be linked to, and supported by, the neighbouring Bayside Community Centre (see Page 148).

Integrating gardens.
As the designs for Quayside are refined, Sidewalk Labs plans to explore the integration of community gardens as key amenities.

Two 307 visitors spend time in the Learning Garden, developed in partnership with Bowery Project. Credit: David Pike

3 Invite participation to a lively, flexible, delightful public realm

What we heard

Participants were excited by the possibility of a flexible, lively public realm that could accommodate a diverse number of uses and needs. Torontonians wanted public spaces that are active with events and programs — that are delightful, playful, and inviting. As the Sidewalk Toronto Fellows put it: "Equip public spaces to become an extension of a front and backyard."

Many participants urged Sidewalk Labs to create spaces that could be enjoyed all year, especially in winter. One 307 visitor pen-named "Cold Australian" asked for "year round comfort in public spaces because Toronto's weather is inhibiting," adding: "I want to live life to the fullest."

Specific ideas for uses that could be accommodated ran the gamut, from dog parks, to spaces for creating and learning, to playgrounds, to outdoor swimming pools. Participants made multiple requests that Sidewalk Labs create opportunities for youths and the arts community to be more present in public space.

While many Torontonians were excited by the flexibility of the spaces proposed, which would give them greater agency over their environment, participants wanted to ensure that flexibility would never preclude accessibility. Some co-design session participants suggested that spaces leverage technology to inform users, in real-time, about the status and layout of these dynamic spaces.

How we responded

Incorporating flexibility.
Sidewalk Labs proposes to create flexible designs for parks, plazas, and open spaces that better accommodate the diverse needs of an expanding population while preserving accessibility. Such spaces would be multi-purpose and could be quickly reconfigured by day or season. Silo Park, for example, should be able to accommodate at least three sports; one "play" feature; space for food and beverage; and recreational spaces designed to be active and accessible all year (see Page 145).

Mitigating weather.
Sidewalk Labs proposes to deploy an outdoor comfort system that can respond to real-time weather patterns, providing protection on rainy, snowy, or windy days and shade on sunny days. Residents or businesses could reserve these tools for gatherings or events (see Page 167).

Sharing infrastructure.
Sidewalk Labs proposes to equip public spaces with shared physical infrastructure (such as projectors or power outlets) to encourage users to program these spaces themselves (see Page 184).

Encouraging arts and culture.
Sidewalk Labs proposes to encourage and celebrate arts and culture through the provision of rotating installations, affordable production space, and a Civic and Cultural Assembly with shared fabrication equipment and a room for exhibits and teaching (see Page 183).

Emphasizing accessibility.
In keeping with its accessibility principles, Sidewalk Labs plans to work with the accessibility community to ensure the accessibility of flexible spaces, including installing options such as wayfinding beacons (see Page 106).

4 Pursue governance models that ensure safe, well-maintained public spaces over the long term

What we heard

The Public Realm Advisory Working Group urged Sidewalk Labs to consider an innovative governance model for public space and to work with the City of Toronto's Parks, Forestry, and Recreation department to structure a sustainable management and funding plan that would ensure public ownership of parks while allowing for innovation in programming, operations, and maintenance.

Participants were similarly concerned about maintenance, wondering how public spaces would be "future-proofed" and how safety would be ensured.

Sidewalk Labs' Craig Nevill-Manning teaches young children how to adjust the lights in the 307 Dynamic Street prototype. Credit: David Pike

How we responded

Proposing the OSA.
To sustain high-quality open spaces over the long term, Sidewalk Labs proposes the creation of the Open Space Alliance as a non-profit entity that could deliver local programming, operations, and maintenance in Quayside. The OSA could also create mechanisms for sustainable funding, staffing, and oversight that ensure the long-term viability of public spaces (see Page 178).

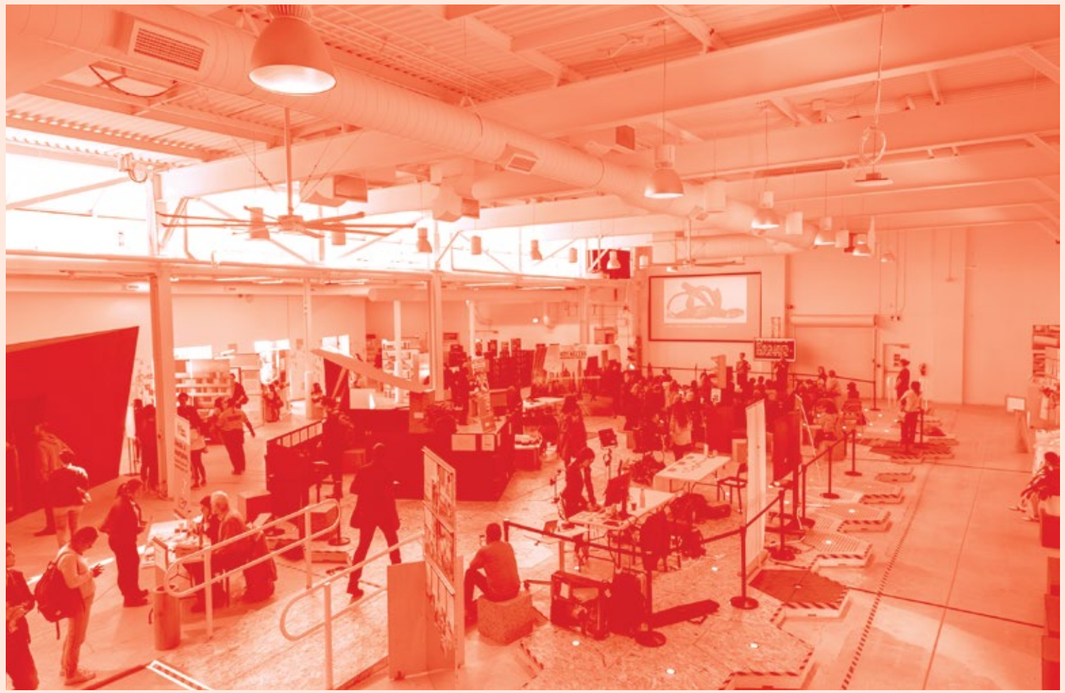
Empowering the community.
Sidewalk Labs has partnered with Park People and the Gehl Institute to prototype CommonSpace, a tool that makes it easier to collect reliable data on how people use public spaces, enabling space managers to see patterns, generate insights, and develop evidence-based approaches to advocating for change (see Page 183).

Leveraging technology.
Sidewalk Labs proposes to create a real-time map of park assets, from drinking fountains to garbage bins, that can help managers operate and maintain public spaces (see Page 186).

Reimagining pavement.
Sidewalk Labs proposes to deploy a novel system of modular pavers that would lower maintenance and repair costs of hardscape in the public realm (see Page 139).

Planning for safety.
Sidewalk Labs incorporated safety into every facet of its planning process and plans to design spaces that promote safety — for example, by including lighting in the public realm that would ensure the appropriate visibility at all times.

Engagement spotlight



Leading Toronto accessibility organizations showcase their work at 307 for Open Sidewalk: The Accessible City. Credit: Jenna Wakani

In developing ideas for the future city, Sidewalk Labs has been interested in exploring a system of prefabricated modular pavers that would enable curbless streets and be easy to maintain and repair. Modular pavers also allow for the embedding of new technologies, such as heating elements to melt snow and ice, LED lighting to communicate new street uses, and permeability to improve stormwater management.

Over the past year, Sidewalk Labs has been prototyping and testing these pavers, and sharing its progress with a variety of groups. At the design jam, "People on Wheels," accessibility advocates were enthusiastic about the pavers, as road maintenance, ice, and snow present some of the biggest challenges for accessibility. But they pointed out an important flaw: the pavers were the same width as wheelchairs, meaning that when crossed at the wrong angle, wheels could catch in the gaps.

It was a crucial insight that took the planning team back to the drawing board. As a result, the team is testing a design of pavers that are now 20 percent wider and — thanks to those co-design participants — would create a more accessible public realm for all.

An expanded public realm, activated by community-driven programs and responsive maintenance, would serve as the foundation of a great neighbourhood.

Acknowledgements

Sidewalk Labs would like to extend special thanks to the participants of the Sidewalk Toronto Public Realm Advisory Working Group, and to the staffs of the City of Toronto, Province of Ontario, and Government of Canada for their time and guidance.

Endnotes

General note: Unless otherwise noted, all calculations that refer to the full proposed IDEA District scale are inclusive of the entirety of its proposed geography, including all currently privately held parcels (such as Keating West). Unless otherwise noted, all currency figures are in Canadian dollars.

Charts note: Sources for the charts and figures in this chapter can be found in the accompanying copy for a given section; otherwise, the numbers reflect a Sidewalk Labs internal analysis. Additional information can be found in the MIDP Technical Appendix documents, available at www.sidewalktoronto.ca/midp-appendix.

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    Open space was expressed as a percentage representing the amount of non-building area on the ground, against the total area of the four blocks. For the Sidewalk Toronto project, Sidewalk Labs envisions that the dynamic curb will allow for useful expansion of open space into the right-of-way, but for the purpose of simplifying calculations, this study took a more strict definition of open space.

    Sky access was calculated at points on an analysis grid which matched the study area and included all four blocks. For every point in the analysis grid not inside a building, Sidewalk Labs computed the percentage of a hemisphere of view which can see the sky. Sky access for the entire study area was then expressed as the average of all individual percentages.

    Gross floor area was calculated by summing the total area of each floor in all buildings. For the precinct plan, ground floors were assumed to be 5 metres high and all other floors 4 metres high. For building massings produced by generative design, floor heights were 5 metres, 4.5 metres, 4 metres, and 3.3 metres depending on use type.

    Sidewalk Labs produced 2,051 different block configurations using the generative design pipeline and evaluated them against the precinct plan with the same measures. The generative design pipeline operated in two distinct modes: (1) modifying and optimizing human-created building massings through geometric operations of translation, scaling, rotation, and reflection, and (2) creating new designs using a series of algorithms for block subdivision and massing creation. For the former, designs from Beyer Blinder Belle were modified to fit on the four blocks; for the latter the pipeline used inputs for target ground floor areas that matched the original precinct plan.

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    This data was used to compute a blended average of street activity for each type of street: 10 hours a day for destination, 10 hours a day for local, and eight hours a day for downtown. Street activity was defined as more than one-third of businesses being open. The average across all three types of streets was nine hours of street activity a day.

    Sidewalk Labs then conducted the same computation for the Sidewalk Toronto project, looking at expected hours of street activity in Quayside, based on an anticipated program in 2035. Due to the more diverse program mix than typical Toronto streets, Sidewalk Labs anticipated 11 hours of street activity a day in Quayside.

    In addition, tenants in Quayside would be able to easily share space. Sidewalk Labs assumed that 20 percent of tenants would participate in space sharing, either through co-tenancy arrangements they broker themselves, or through shared space by design, as seen in the stoa. The impact of space sharing is that the street would be active for an additional hour, as it is anticipated that businesses with complementary opening hours will co-locate. That takes Quayside's total average street activity to 12 hours a day, in contrast to nine hours a day seen on typical streets in Toronto.

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Chapter 3

Buildings and Housing

Ch–3

Introduction

The Vision

Sustainable buildings that can be **constructed and adapted far more quickly**, and a new set of financial and design tools that help **improve affordability** and **expand options** for all households.

For two years running, Toronto has hoisted more construction cranes than any other city in North America.[1] But for a city that is a leader in openness and inclusion, it has been hard to achieve ambitious levels of affordability during the building boom.

Much of Toronto's new skyline consists of condo towers priced out of reach for the median Toronto household, which makes roughly $66,000 a year.[2] Faced with great uncertainty around construction costs (rising at 6 to 8 percent annually in recent years)[3] and completion timelines, developers often build condos they can sell before breaking ground. In the last 20 years, 77 percent of the new housing stock in Toronto has been condos.[4]

To help, all levels of government have increased support for affordable housing programs, but additional funding is needed, as are viable paths to create new private sources. Half of households earning $40,000 to $60,000 are housing "burdened," spending more than 30 percent of their income on rent.[5] Few options exist for middle-income households that do not qualify for housing programs but also cannot afford market-rate homes.

Beyond housing, economic opportunity improves with true live-work communities that host a lively mix of homes, offices, shops, and services. Such neighbourhoods provide residents with easier access to jobs and essential daily services and with housing options for families to grow over time. They also provide affordable commercial space in buildings and on ground floors for local retailers, community groups, artists, and startups, not just big chains and corporate offices.

The innovation plan.

To help Toronto's waterfront achieve its goals for a mixed-income community that builds on the city's diversity, and to demonstrate a path forward for affordability and economic opportunity in high-demand cities, Sidewalk Labs proposes a comprehensive strategy for construction, building, and housing innovation.

First, Sidewalk Labs proposes construction innovations that would accelerate project timelines while reducing costs and uncertainties, helping developers look beyond condo towers. This plan centres on a new factory-based construction approach, enabled by an emerging building material called "mass timber," which is easier to manufacture and better for the environment than concrete or steel, yet just as strong and fire-resistant. Digital building information modelling tools could support this factory approach by coordinating projects across the supply chain.

Second, Sidewalk Labs proposes building design innovations that could accommodate the full range of live-work needs and respond nimbly as those needs change. These include adaptable "Loft" spaces — supported by flexible interior panels and a real-time code-monitoring system — designed to cut renovation times and help communities retain a lively mix of businesses and residents. For homes in particular, efficient units and co-living spaces could improve affordability while expanding options for all types of households.

Finally, Sidewalk Labs' proposed housing innovations aim to realize an ambitious affordability program wherein 40 percent of units are below market rate, with half of the program's total units consisting of purpose-built rentals to improve long-term affordability. To achieve this program, Sidewalk Labs proposes to implement new tools that could help the private sector support below-market rental housing while still earning returns, including through leveraging the value created by factory-based construction.

With a commitment of at least 6 million square feet of construction along the waterfront, an Ontario-based factory could be financed and ready for operation by 2021, leading to 350,000 work hours during the development of Quayside.[6]

Benefits of implementing the vision

- Accelerate construction timelines by as much as 35 percent
- Unlock a new Ontario-based sustainable mass timber industry, creating roughly 2,500 jobs over 20 years of development at the scale of the IDEA District
- Generate over $1.4 billion for below-market housing through 2048
- Enable buildings to support evolving live-work communities through fast, affordable renovations

IDEA District

The 77-hectare Innovative Design and Economic Acceleration (IDEA) District, consisting of Quayside and the River District, provides sufficient geographic scale for innovations to maximize quality-of-life impact and to become financially viable.

The impact.

In Quayside, Sidewalk Labs estimates that factory-based construction techniques could demonstrate that it is possible to reduce construction timelines by as much as 35 percent,[7] while creating the world's first neighbourhood made entirely of sustainable mass timber. Adaptable structures could allow for a true live-work community by making renovations easier, with 50 percent lower costs and timelines. An ambitious housing affordability program could provide roughly 1,000 below-market units, including new options for middle-income households, growing families, and seniors.

Applied to the proposed full scale of the IDEA District, Sidewalk Labs' approach could go even further towards addressing the city's objectives concerning affordability and opportunity.

At this greater scale, factory-based construction could give rise to a new Ontario-based sustainable timber industry, creating roughly 2,500 jobs over 20 years and unlocking new land value through faster project timelines and reduced risks. Sidewalk Labs estimates that the total value created by factory-based construction, efficient housing designs (which enable developers to build more units on a given site), and other proposed financial tools (such as a condo resale fee to support mixed-income communities), could reach over $1.4 billion through 2048. This approach would also demonstrate a viable and replicable path for the development sector to support the public sector in improving housing affordability.

Such a program could include around 6,800 affordable housing units, representing nearly a third of the current annual citywide target for new affordable rental housing units, in accordance with the city's Open Door program,[8] or well over half the goal if the definition of affordable housing is expanded to include middle-income households in need.

Most of all, this approach could provide a model for Toronto to welcome its consistent influx of new arrivals — roughly 1 million additional people are projected to live there by 2041[9] — allowing the city to maintain its exemplary commitment to inclusion.

This housing vision could create over 6,800 units of affordable housing, tackling nearly a third of the annual city-wide targets for new affordable rental housing.

Ch–3

Part 1

Accelerating Construction Timelines

Key Goals

1
Catalyze a new sustainable industry around mass timber

2
Launch a factory to produce a complete library of building parts

3
Coordinate the supply chain with a digital delivery system

The ability for development projects to go up quickly is critical in helping cities meet new demands for residential or commercial space. But in Canada and around the world, developers face a number of challenges that make it difficult to complete projects on predictable timelines and with predictable costs.

Perhaps the biggest challenge is the unpredictability of finding (or, in developer speak, "sourcing") a set price for the many building materials needed for a given project. Costs keep rising for concrete and steel[10] — the main urban building materials — and customized designs make each project time-consuming. Both factors can lead to construction delays or project cancellations; even in a high-demand market like Toronto, at least 17 projects have failed since the start of 2017 alone.[11]

The challenge of accelerating urban construction is not new, but no one has yet cracked the code, stymied by heavy building materials that are hard to produce in a factory and the difficulty of coordinating a construction supply chain across designing, financing, contracting, and permitting. In general, off-site (or mass-produced) construction has yielded repetitive designs applied mainly to single-family homes, hotels, and temporary housing.

But the time is right for off-site construction to take hold. Today, advances in technology are shifting the paradigm for urban construction. A wave of companies around the world is taking advantage of lightweight materials (such as mass timber), robotic machinery, and building information modelling software to construct architecturally distinct buildings faster, and at a lower cost, including: Lindbäcks Bygg in Sweden, Legal & General in the U.K., Sekisui House in Japan, Admares in Finland, and Katerra and Factory OS in the U.S.

Off-site mass timber construction can accelerate project timelines by 35 percent, reduce costs, and greatly improve overall predictability.

Vancouver's 18-storey all-wood Brock Commons went up at two floors per week.

Canada has demonstrated the promise of this approach with discrete projects. Recently, Toronto has seen the emergence of higher-quality modular construction, such as the Great Gulf Home factory, although this work has focused on low-rise buildings.[12] In Vancouver, the 18-storey, all-wood Brock Commons building on the University of British Columbia campus went up at a speed of two floors per week for the basic structure.[13]

Sidewalk Labs proposes to advance these efforts by committing to use prefabricated building components in Quayside and beyond. This commitment would enable the establishment of a factory in Ontario, which Sidewalk Labs is willing to support financially, potentially in partnership with others. Such a factory would process mass timber building parts and catalyze a new industry around this sustainable material.

Sidewalk Labs also proposes to create a library of building parts that could be combined in thousands of different ways to ensure design excellence and to develop a digital management system that coordinates the entire supply chain from conception to completion.

Together, these approaches can accelerate project timelines by 35 percent, reduce costs below current market rates, and greatly improve overall predictability for any given development.[14]

Goal 1

Accelerating Construction Timelines

Catalyze a new sustainable industry around mass timber

The first step in Sidewalk Labs' proposed approach to construction innovation is the wide-scale manufacturing of mass timber, a sort of "super wood" created by compressing multiple pieces of timber together.

Wood ranks among humanity's most ancient building materials, but today conventional timber is mostly used to create simple two-by-four wood structural elements (such as beams) for low-level housing. Mass timber emerged in Central Europe in the mid-1990s as a much stronger material than conventional timber, with the potential for use in tall urban buildings.[15] It is as strong as steel and twice as strong as concrete by weight — yet far easier to manufacture and faster to assemble.[16]

Mass timber is also far more sustainable than steel or concrete. Trees "sequester" carbon as they grow — trapping 1 tonne of carbon dioxide in every cubic metre of timber.[17] In this way, buildings made of timber act as a vault, storing carbon that otherwise would have been released back into the air through decomposition. For example, the timber required to build Brock Commons in Vancouver stored 1,753 tonnes of carbon dioxide, the equivalent of taking 511 cars off the road for an entire year.[18] Mass timber also improves air quality and has "biophilic" properties, the term for human health benefits ascribed to interaction with nature (see Page 211).

Sidewalk Labs plans to support the launch of an Ontario-based factory by 2021 that would process two mass timber products: cross-laminated timber structural panels and glulam beams. This factory would use Canadian-sourced mass timber — specifically spruce trees from the boreal forests of Quebec and Ontario and Douglas fir trees from British Columbia, the two dominant types of wood in the traditional North American timber industry. The factory would operate in collaboration with Canadian foresters, sawmills, and other industry partners.

In Quayside, Sidewalk Labs proposes to use mass timber in all buildings it develops, with the goals of proving out the technology's viability up to around 30 storeys, a new record, and of becoming the world's first fully mass timber neighbourhood. Using wood for all 2.6 million square feet of building development in Quayside would be equivalent to removing over 20,000 cars from the road annually.[19]

Across the full scale of the IDEA District, Sidewalk Labs proposes to require third-party developers to use materials that meet the sustainability standards of those buildings planned for Quayside, which would be substantially constructed of mass timber. If mass timber materials were used in the IDEA District, they would need to be certified by the international Forest Stewardship Council or equivalent forest certification bodies.

Benefits spotlight

Health, wellness, and mass timber

Mass timber is not just sustainable for the natural environment — it can also help sustain people inside the built environment.

A wide range of research shows that exposure to natural environments and materials elicits restorative responses in the body and brain.

Healing.
A seminal 1984 study by architect Roger Ulrich, which has since been replicated many times, found that surgery patients whose recovery rooms had a window view of natural scenery recovered faster and required fewer painkillers than those whose rooms did not.[20]

Stress reduction.
Japanese researchers have shown that a short walk through a natural environment reduces the body's production of cortisol (the fight-or-flight hormone) and keeps it down for hours afterwards.[21]

Comfort.
Another Japanese study showed that, in rooms with 45 percent of their surface areas covered by wood, participants not only found the room comfortable, their diastolic blood pressure decreased while their pulses quickened — a kind of relaxed alertness.[22]

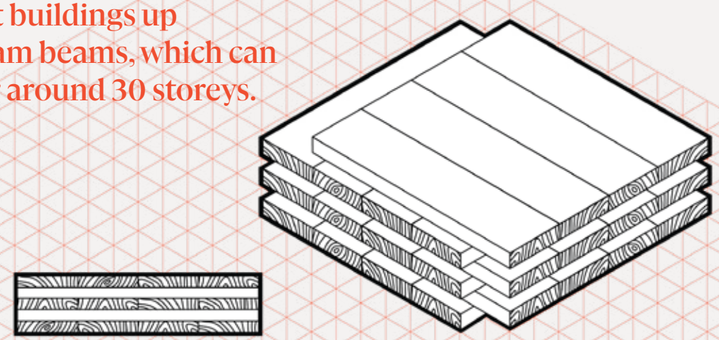
Calming.
Exposure to nature has been found to calm the subgenual prefrontal cortex, the part of the brain responsible for mental brooding. Neurologists believe it takes as little as 40 seconds of staring at an image of natural scenery for this calming effect to kick in.[23]

Cognition.
A 2008 University of Michigan study compared the cognitive effects of walking through downtown Ann Arbor with the effects of strolling through the city's arboretum. The nature walk restored voluntary attention — responsible for such tasks as problem-solving — far more effectively.[24]

Concentration.
A 2012 study from the University of Texas at San Antonio showed that, in workplaces, the presence of fractals (self-repeating patterns at a variety of scales, from small to large) serves as a buffer from stress that can help people perform challenging mental work.[25] Wood grain is, in essence, a series of fractals — like snowflakes, no two wood pieces are ever alike.

Two types of mass timber parts

To help Quayside become the world's first entirely mass timber neighbourhood, an Ontario-based factory would process cross-laminated timber panels, which can self-support buildings up to around 10 storeys, and glulam beams, which can provide structural support for around 30 storeys.



Cross-laminated timber panels

Sidewalk Labs plans to use cross-laminated timber, commonly called CLT, to manufacture structural wall panels and floor plates. In Quayside, Sidewalk Labs proposes to create a 10-storey building entirely from CLT.

Composition.

The creation of CLT begins by milling a piece of wood ranging from 15 to 35 millimetres thick. Typically, three to seven layers of such pieces are arranged with the grains perpendicular to each other, then are compressed together with a green-certified glue to create a panel of up to 4-by-18 metres.[26]

Adhesives.

The most common adhesives for CLT are polyurethane-based, or PURs, which are free of solvents and of formaldehyde, and ensure both low toxicity and capacity for future reuse or recycling. Industry testing has demonstrated that CLT panels utilizing PURs have no impact on internal air quality by the emission of volatile organic compounds, commonly called VOCs.[27]

Strength.

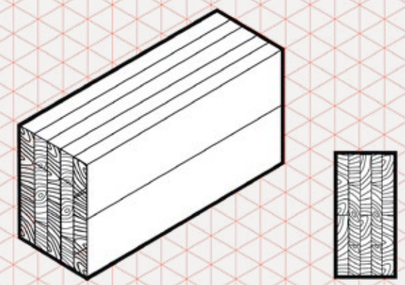
Whereas traditional timber is only strong in the direction of the grain, CLT's layered arrangement gives it strength in two directions.[28] A typical CLT wall panel is capable of bearing a vertical force of 197 kilonewtons per metre, which is equal to four elephants standing on top of a one-metre section of wall.[29] As a result, CLT wall panels and floor plates have enough strength to support up to a 12-storey building on their own, without the need for the structural beams and posts used in conventional mid-rise constructions of the same height, thus freeing up the interior space typically devoted to beams and posts.[30]

Shipping.

To optimize for shipping, CLT panels can be manufactured to fit a standard articulating truck. That means a truck can be packed up to 50 percent full with CLT walls and floor plates, with the rest of the cargo weight going towards racks that hang these pieces. By contrast, when shipping steel, a truck is considered overweight after only 5 percent of its cargo volume is filled, given the weight of the material. (More on shipping on Page 226.)

Assembly.

CLT panels can be manufactured with interlocking metal cleats at both ends to accelerate assembly.[31] The assembly speed is extremely fast because there is no need to use structural posts and beams or partition walls for structural support. While CLT panels can be treated with any type of paint or plaster, design experts believe 45 percent of the natural wood should be exposed to get the full health benefits of its biophilic properties. (More on assembly on Page 227.)



Glulam beams

For buildings that exceed the 12-storey structural limitations of CLT, Sidewalk Labs proposes to use a different type of mass timber called glulam to manufacture structural posts and beams. In Quayside, glulam supports (along with CLT floor panels) would be used to develop buildings of around 30 storeys tall, a new record that would demonstrate the technology's capabilities.

Composition.

Glulam's name comes from the use of glue to laminate wood together. Glulam is made using three to nine layers of timber, but unlike CLT, glulam is made with the timber grains oriented in the same long direction. As a result, glulam has immense load-bearing strength across the length of the beam or straight down a post — the same support steel offers in traditional construction.

Adhesives.

The adhesives used in glulam are also PURs.

Strength.

Glulam beams and posts, combined with CLT panels and floor plates, would provide the technical strength to support a skyscraper as tall as the Empire State Building.[32] However, as a building's height increases, the size of the glulam beam necessary to support the structure expands significantly, reducing the amount of usable interior space. With existing engineering, the beam size would become intrusively large, or 1.5 metres deep, when a building exceeds around 30 storeys.

Shipping.

Like CLT, glulam materials are half the weight of steel beams and posts, making them easier to transport. Whereas a typical truck can handle two or three steel beams, it can carry 10 times as many glulam beams.

Assembly.

As with CLT, the lighter weight of glulam makes these pieces easy to assemble on-site via metal cleats.

Ensuring fire resistance with “Shikkui plaster”

When people first learn about the prospect of tall wooden buildings, their first question is often: “What about fire?” Despite this reasonable concern, mass timber is engineered to be not only more fire-resistant than typical wood[33] but just as fire-resistant as concrete or steel.[34]

As a primary form of fire resistance, mass timber panels can be designed with an outer layer of wood in place solely to provide a “charring layer,” which acts as a buffer, protecting the interior (and structurally essential) layers from further combustion.[35] These fire-resistant charring layers protect mass timber pieces that are exposed (or viewable) as part of a building’s interior design. These layers also help extend the life of a mass timber building, because they can be replaced (rather than demolished) if charred.[36]

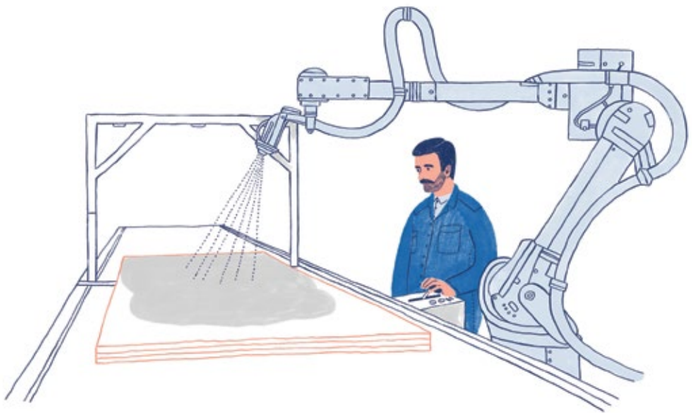
Alternatively, mass timber panels designed without charring layers (to reduce size) could be protected by a non-combustible fire-insulating panel, such as drywall. But the use of drywall, which is the typical construction practice, is labour intensive and wasteful: it generates nearly 12 million tonnes of debris every year.[37] That debris represents up to 27 percent of overall construction waste[38] and often languishes on construction sites as a potential hazard; eventually, it goes to landfills, where it becomes poisonous gas,[39] negating some of the sustainability benefits of using mass timber.

In search of a better form of protection, Sidewalk Labs is developing new applications for a natural plaster system called Shikkui plaster, which has a fire-resistance rating comparable to that of drywall (see sidebar on Page 215) and has many additional advantages, including sustainable properties, health benefits, faster application times, and a green waste stream.

Made from natural ingredients, including slaked lime, seaweed extracts, eggshells, and plant fibres, Shikkui plaster has been used in Japan for over 1,000 years on walls and ceilings as an aesthetic finish that also protects wood buildings against water and fire damage. As a hybrid of natural substances, Shikkui is completely environmentally sustainable (receiving the globally recognized Cradle to Cradle certification), fully recyclable and compostable, and produced with low amounts of energy. Its low carbon footprint is reduced even further as it continuously absorbs carbon dioxide after installation.

Shikkui also provides health benefits: its high alkalinity makes it a natural killer of bacteria and mold, and its anti-static properties prevent the accumulation of dust that allergens feed off of. Additionally, its finish includes customizable textures and colours, enabling interior variety with no need for any paint.

The Shikkui system can also accelerate construction timelines. Sidewalk Labs plans to mechanically install Shikkui onto mass timber panels in a factory, cutting the amount of time typically devoted to the application of paint and drywall in half. This approach results in a waste stream that can be recycled as plant-beneficial fertilizer.[40]

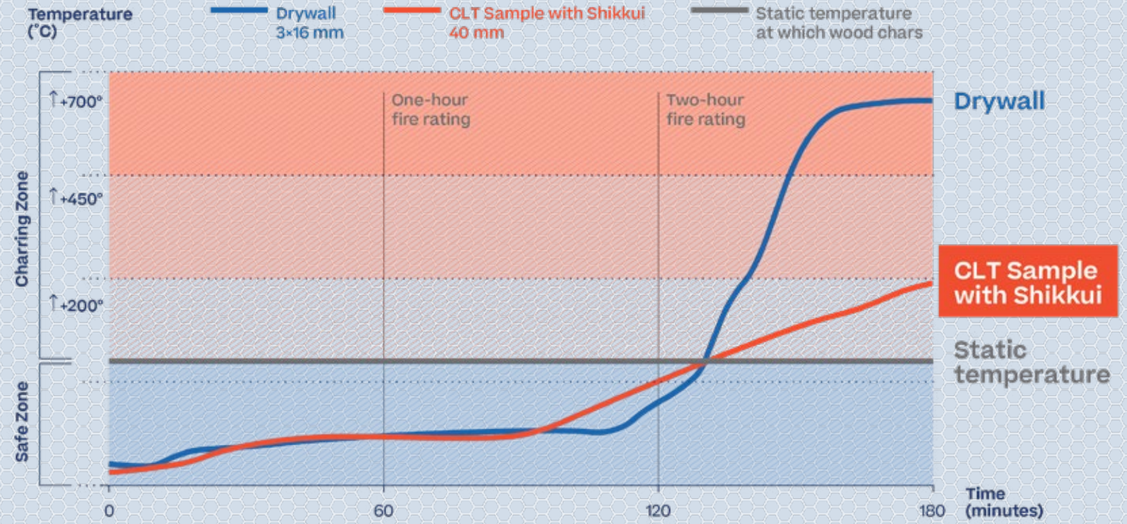


Mechanically applying Shikkui plaster to mass timber panels can help accelerate construction timelines.

In Focus

Independent test results

Shikkui system matches drywall on fire protection



To demonstrate the fire-resistance of mass timber panels coated in Shikkui plaster, the coated panels must meet the American Society for Testing and Materials (ASTM) E119 standard called “Standard Test Methods for Fire Tests of Building Construction and Materials.”[41]

The ASTM E119 test is designed to assess how well building elements can contain a fire and maintain structural integrity over a given time period, commonly referred to as one- and two-hour “rated assemblies” — the same standard achieved by double and triple five-eighths-inch drywall. These time periods are considered long enough for occupants to safely evacuate, and for firefighters to control the fire damage.

(On its own, Shikkui plaster already meets the Class A rating for the ASTM E84 standard, also known as the Steiner Tunnel test, meaning that it does not let fire spread across its wall or ceiling surfaces.)

The ASTM E119 test places the plaster-coated mass timber panels in a flat furnace and subjects them to a controlled flame. Within five minutes, the furnace reaches temperatures of 537 degrees Celsius, rising to 927 degrees Celsius at one hour and to 1,010 degrees Celsius during the second hour. The furnace test continues until the target one- or two-hour test limit is successfully achieved or until an unsuccessful outcome occurs, such as when the structure collapses or the material surface reaches a temperature of 300 degrees Celsius.

Preliminary tests conducted by an independent laboratory achieved the one- and two-hour “rated assemblies,” meaning the Shikkui-coated mass timber withstood exposure for both one and two hours, as required by ASTM E119. Further tests will be conducted in a state-of-the-art, certified independent laboratory and supervised by the National Research Council Canada.

Strengthening wind resistance and building cores

Mass timber is about half the density of concrete or steel. While that makes it easier for trucks to ship and for construction workers to assemble, this lightness also makes mass timber structures more susceptible to wind, especially once they exceed 10 storeys (depending on building massing).

Many of the tallest timber buildings in existence today integrate steel-based external frames or other lateral support systems to anchor and stiffen the building against wind, but adding steel detracts from timber's sustainability advantages. As part of the planning process, Sidewalk Labs explored three potential innovative building cores that could be used to strengthen resistance from wind and seismic activities for mass timber buildings. Sidewalk Labs plans to explore which cores provide the best fit for buildings developed in Quayside, and to make all three options publicly available for third-party developers to consider for their own building needs.[42]

Timber cores.
For buildings up to 12 storeys, cores made entirely of timber could be a viable alternative to external frames, maintaining the building's low carbon footprint.

Prefabricated steel cores.
For buildings higher than 12 storeys, a new type of prefabricated steel core could anchor the building. Although lacking the environmental advantages of timber cores, this approach has the potential to reduce on-site construction times by roughly one month over traditional concrete cores, with steel cores (including elevator rails) delivered straight to a site from a factory.

Hybrid.
The exploration also found potential in a new type of timber core that incorporates post-tension steel cables to increase the overall stiffness of the core. This option could support timber structures of at least 30 storeys, while offering a more sustainable option than a steel core.

Making Ontario a global leader

Canada has all the ingredients for a transformative industry in mass timber building materials.

The country owns about 37 percent of the world's certified forests, defined by the international Forest Stewardship Council as areas that can be harvested for wood in a sustainable way, with proper spacing to regrow trees and with access to existing railways or roads to transport supplies.[43] Almost half of Canada's 374 million hectares of forests are certified. Roughly half a billion new seedlings are planted every year. The $24.6 billion forestry industry in Canada employs more than 200,000 people (including more than 12,000 from Indigenous populations), with more than half of all jobs located in Ontario and Quebec.[44]

Canada harvests nearly 800,000 hectares of timber per year, but devotes the majority of that supply to framing lumber, such as simple two-by-fours or plywood. As a result, Canada currently imports mass timber parts from Austria and other production centres.

By supporting the launch of a factory in Ontario for the construction of mass timber structures in the IDEA District, Sidewalk Labs would help jumpstart this next-generation Canadian industry. This newly expanded supply chain would begin with local foresters and sawmills creating the baseline CLT and glulam pieces, which would then be sent to the factory to be cut into assembly-ready posts, beams, and panels — part of the complete library of factory-made building parts described in the following section of this chapter.

Engaging the timber community.
Sidewalk Labs has engaged more than 150 stakeholders across this potential supply chain to figure out what needs to happen to make Ontario a global leader in what could be a major piece of the future of urban building. Part of the answer is a commitment to ensure that the demand for mass timber starts at the proposed 6 million square feet of development — with the potential to grow to 33 million square feet at the full scale of the IDEA District.

An equally important factor is supporting close collaboration among designers, contractors, and manufacturers, thus establishing partnerships that might not be in place today across trades (see sidebar on this page).

To jumpstart the process of collaboration, Sidewalk Labs has hosted or planned a series of industry events focused on mass timber. To date, these events have included an overview of the Sidewalk Toronto project and a design review of Sidewalk Labs' proposed library of building parts to construct a building. Future events are expected to include discussions of risk mitigation and capacity building. (More information is available at the Sidewalk Toronto project website.)

By helping to grow the capabilities of local players, and by building on the timber industry's momentum, Sidewalk Labs can enable a sustainable ecosystem for mass timber that can contribute to further innovation in timber construction and realize economic benefits for the city, province, and country for decades to come.

Sidewalk Labs small research grant

Modular timber construction in Ontario

The use of mass timber to construct high-rise buildings has enormous appeal. But as with all new technologies, costs are expected to be higher at first, as production techniques are worked out and economies of scale are developed. That is also true in the regulatory world. Permitting and code agencies are unfamiliar with mass timber and may at first take more time and be less predictable in their judgements, which adds to costs.

In the report "Mass Timber in High-Rise Buildings: Modular Design and Construction," commissioned by Sidewalk Labs, authors Dalia Dorrah and Tamer E. El-Diraby, professor in the Department of Civil and Mineral Engineering at the University of Toronto, recommend that industry and government work together to accelerate the process of lowering costs and streamlining techniques, both industrial and regulatory. Doing so can help unlock the potential to build a vital new industry in Ontario, which could supply a new economic base while improving the built environment of Toronto and the region.

To this end, Dorrah and El-Diraby propose that developers, manufacturers, contractors, and government officials work to establish councils and partnerships to share information. One difficulty, the authors argue, is the fear that mass timber buildings would be fire hazards. Studies show this concern is misplaced, but the issue needs to be addressed head on.

They also suggest using an Integrated Project Delivery System, where owners and contractors can share information more fully, as well as a three-dimensional modelling system known as building information modelling (BIM). These tools would establish the common contractual and technical platforms that would boost cooperation and collaboration.

Finally, Dorrah and El-Diraby say development of mass timber has another potential side benefit: it could test the resiliencies of contractors and developers as they work out new techniques, ultimately better preparing them for a changing market.

Catalyzing a sustainable mass timber supply chain

Sidewalk Labs would build on Canada's growing efforts to embrace mass timber by reimagining the supply chain, harvesting local sustainable timber that would be processed in a new Ontario-based factory. The resulting construction process would be faster, more predictable, less expensive, and better for the environment — jumpstarting a new national industry.

1 Harvesting sustainably.
The supply chain would begin with local foresters harvesting timber in a sustainable way.

2 Collaborating with local sawmills.
Harvested timber would then make its way to local sawmills, where it would be turned into CLT and glulam pieces.

3 Manufacturing a library of parts.
The new factory would then cut and prepare these mass timber pieces into assembly-ready wall panels, floors, beams, and posts (in addition to preparing other components of its building library).

5 Assembling faster.
Mass timber parts would be fitted with a cleat system that would make assembly fast: the structure could go up as quickly as one floor per day.

4 Shipping to the site.
Once ready for assembly, mass timber parts would be efficiently shipped to a construction site.

Goal 2

Accelerating Construction Timelines

Launch a factory to produce a complete library of building parts

A set of mass timber structural pieces is the foundation for a new, factory-based approach to sustainable urban development. But a building consists of more than panels and beams. To accelerate project timelines, improve predictability, and reduce costs in a holistic way, Sidewalk Labs plans to establish a complete library of factory-made building parts available to all developers — whether in the IDEA District, elsewhere in Toronto, or around the world.

The building parts created and assembled in this new factory would be produced in sufficient volumes to reduce both costs and sourcing time for developers and contractors. Sidewalk Labs has started to work closely with local regulators to enable these pieces to be pre-approved, creating more certainty around construction timelines and the permitting process. These parts would still be customizable by architects seeking to deliver distinctive designs, as the same library of parts can lead to dramatically different buildings.

The result would be unique designs built on a faster, more predictable timeline, with reduced risks and opportunities to lower key project cost categories. These benefits emerge from several areas:

Materials procurement.
Pre-determined components could create more predictable, shortened timelines for sourcing and procurement. Bulk purchases would also cut the rising cost of materials, ensuring consistent pricing.

Design.
A pre-designed library of parts would reduce time spent on designing. A pre-established strategy around technical details (such as fire-resistance ratings, acoustics, and deflection, as well as mechanical, electrical, and plumbing integration) would dramatically reduce overall design time and cost.

Assembly.
The easier on-site assembly of prefabricated mass timber parts would accelerate project speeds, saving time and reducing project management costs and site operational costs during the construction period.

Transportation.
Developing a library of parts created to optimize shipping would reduce transportation costs.

Factory-based construction of building parts would result in less waste, better working conditions, and streamlined regulatory approvals.

Waste.
Finishing parts in a factory would capture waste for recycling and nearly eliminate on-site waste.

Labour.
Off-site factory conditions would improve productivity and reduce on-site supervision needs, while also reducing risks of injury.

Regulatory approvals.
Pre-certified building components and assemblies would create clarity on meeting code and permit reviews.

Contingency.
The greater reliability of the factory supply chain would reduce the need for developers to build “contingency” costs into their projects.

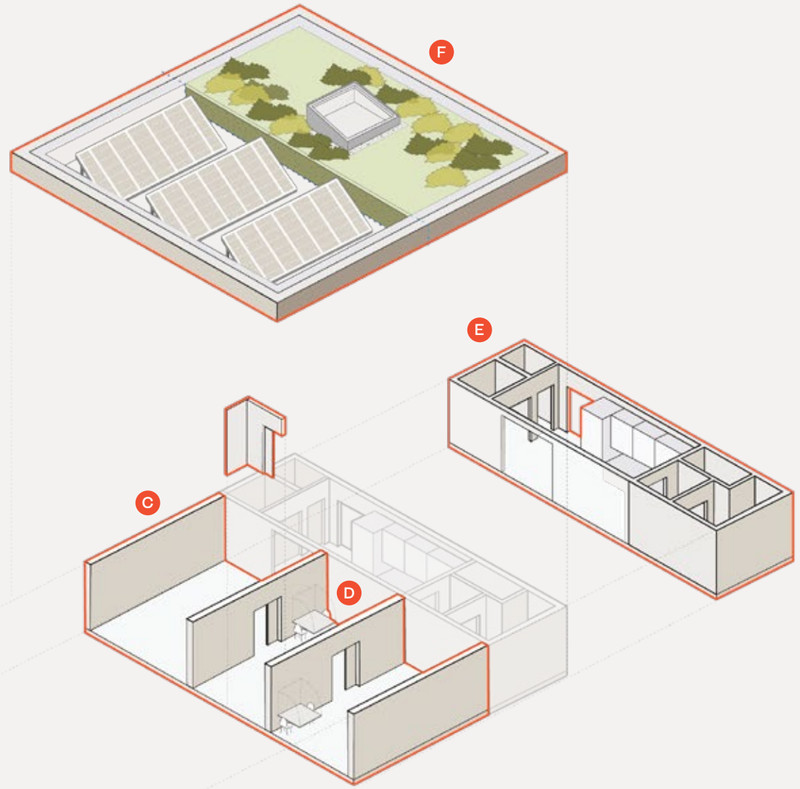
Sidewalk Labs has considered a wide range of building materials and technologies and will continue to explore others in the hopes of further improving the sustainability of the system and the efficiency of the construction supply chain. Some of these innovations are designed to be integrated in tall timber systems (such as new manufactured timber products or wall systems) and others have driven innovation in other industries but could be incorporated in building systems (such as mineral wool insulation and pressurized walls and windows).

The following sections describe these benefits in greater detail. By injecting more certainty into the building process, Sidewalk Labs hopes to enable projects that meet both the city’s objectives for affordability and the waterfront’s standards for aesthetic excellence.

The six core components that make up the library of parts

The proposed off-site factory would process six core building components: exterior facades and windows, exterior wall systems, structural elements, interior wall systems, kitchens and bathrooms, and building roofs. Together, these parts can improve predictability of design and procurement of parts for developers.

Working in collaboration with local foresters, sawmills, and suppliers, the proposed off-site factory would produce and assemble the building parts shown here, helping to reduce the time spent sourcing and procuring materials and conducting initial designs, while also making the costs of materials more predictable.



A Exterior facades and windows.
The success of manufactured buildings will rely in large part on the ability of architects to design structures that do not look like they just rolled off a factory line. Sidewalk Labs' proposed building library would incorporate a customizable facade system that includes windows of all shapes, shades, and sizes, and outer cladding (or coating) of different materials to help create unique exteriors.

As part of this facade kit, Sidewalk Labs plans to incorporate a type of triple-paned electrochromic glass that can be used for windows, skylights, facades, or curtain walls.[45] Electrochromic glass can be tinted — either manually, by building occupants, or automatically, by a building management system — to deflect heat before it enters a building, reducing the need for air-conditioning and leading to lower utility bills. While this technology is not new, it has only recently become affordable and customizable in a way that lends itself to widespread use.

B Exterior wall systems.
Exterior wall systems form the outside structure of a building. These walls can be made out of any number of materials, such as non-structural CLT panels or glass curtain walls. The factory would produce or assemble facade panels that meet Toronto Green Standard Tier-3 sustainability standards, creating an airtight building seal that reduces the need for heating and cooling.

See the "Sustainability" chapter of Volume 2, on Page 296, for more details on energy-efficient building designs.

C Structural elements.
As described on Page 212, Sidewalk Labs plans to create structural components from mass timber that include CLT building floor plates, CLT structural wall panels, and glulam beams and posts, as well as the standardized cleats and fittings required for their assembly.

D Interior wall systems.
Interior wall systems include non-structural walls and the electrical and water systems that typically come with them. Sidewalk Labs would incorporate a new system of flexible interior walls that could be easily clipped into place for faster renovation, while being every bit as strong as interior walls commonly used today. These walls would feature mist-based fire systems and low-voltage power systems (see Page 246 for more details).

E Kitchens and bathrooms.
Kitchen and bathroom units are the most complicated and time-consuming on-site construction elements in residential buildings, as tile layers, electricians, plumbers, and fixture installers all try to work in the same small space at once. For these reasons, Sidewalk Labs would pre-assemble these units in a factory, where each of these trades can be sequenced to avoid conflicts and to achieve higher-quality installations. These units would be customizable with appliances, finishes, and colour schemes to meet individual styles and preferences. Sidewalk Labs is working with partners to develop appliances specifically designed for a new low-voltage power system (see Page 247).

F Building roofs.
Sidewalk Labs plans to assemble several types of building roofs, including photovoltaic roofs designed to harvest solar energy, green roofs to integrate nature or garden space into the building structure, and "blue roofs" to help manage stormwater. Blue roofs would have a predesigned flow rate to significantly slow down the volume of water leaving the roof, helping to avoid downstream or localized flooding.

With this same library of parts, architects and developers would be able to create dramatically different buildings that achieve the highest design standards while still cutting costs; three illustrative examples from global architecture firms are shown in the accompanying visuals.

Global design exercise

Creating three unique designs from one library of parts

Sidewalk Labs' library of factory-made building parts can be combined in thousands of ways to produce strikingly different designs. Using the same set of modular components, three global architecture firms developed creative design concepts for Quayside's mass timber buildings (for illustrative purposes only).

Library of parts interpretation: Michael Green Architecture (Vancouver).

Michael Green Architecture envisioned wood buildings for Sites 1 and 2 in Quayside that incorporated garden spaces into the design and aimed to create a diverse range of public and private spaces on the lower floors. Overall, these designs aimed to strengthen connections with nature and with fellow community members. Credit: MGA | Michael Green Architecture

Library of parts interpretation: Snøhetta (New York).

Snøhetta used the Sidewalk Labs mass timber toolkit to create designs for Sites 3 and 4 in Quayside that prioritized adaptability, with lower-floor stoa spaces anchoring a vibrant open-air plaza beside Parliament Slip. The wood system also enabled the team to envision an architecturally striking "hull" that curves atop this public space. Credit: Snøhetta

Library of parts interpretation: Heatherwick Studio (London).

Using the mass timber library of parts, Heatherwick Studio created a design for Site 5 in Quayside that is both expressive and unique. Freed by the modular system from the need to focus on "how" to achieve the building, the team envisioned a more intimate scale for the site that connects with the public realm and the waterfront. Credit: Picture Plane for Heatherwick Studio

Saving on waste, shipping, and assembly

Sidewalk Labs estimates that its efficient factory process would produce a 75 percent reduction in waste, 85 percent fewer deliveries to a construction site, and a 35 percent acceleration of assembly compared with typical on-site construction techniques.

Waste

Reducing waste by 75%

	Concrete	Timber
Number of dumpsters required		
Single building Residential Site 2	303	76
All Quayside	**5,066**	**1,271**

75% fewer dumpsters

The manufacturing process nearly eliminates site waste, because the prefabricated mass timber pieces are designed as perfect fits, and new sizes can easily become standardized over time. Additionally, as noted on Page 214, Shikkui plaster dramatically reduces waste compared to drywall. For example, in Quayside, the use of Shikkui will divert over 275 tonnes of drywall debris from landfills.

Shipping

Reducing truck site deliveries by 85%

Note: These figures account for structural parts only and do not include shipments for foundations and building fit-outs.

	Concrete	Timber
Number of trucks required		
Single building Residential Site 2	695	90
All Quayside	**11,619**	**1,505**

85% fewer trucks

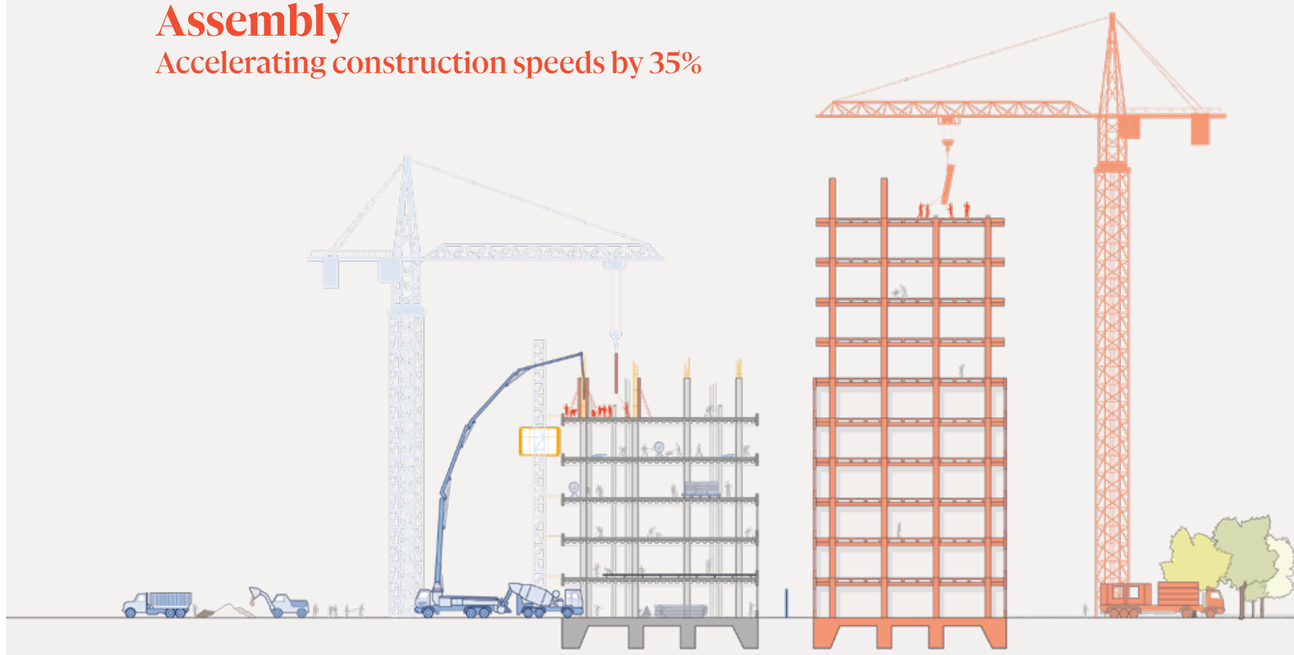
Shipping has traditionally been a difficult challenge for factory-produced structures. While whole rooms might be cheaper to assemble off-site than on-site, they are far more expensive to ship — in effect, shipping an empty room means paying to ship air.

Sidewalk Labs' library of building parts would be designed to maximize shipping efficiency, reducing the transportation costs that have hampered manufactured buildings in the past. As noted on Page 212, the lightness of mass timber makes it possible to fill a standard truck with far more parts than is possible with steel or concrete. A single 40-foot truck can hold either 18 CLT floor panels, 18 CLT wall panels, a mix of six panels and six walls, and two "wet boxes" (kitchens or bathrooms), or roughly 20 beams or posts.

On average, mass timber post and beam structures require up to 85 percent fewer deliveries to a construction site than concrete structures do, dramatically reducing the amount of congestion and neighbourhood disruption.

Assembly

Accelerating construction speeds by 35%



Sidewalk Labs' factory-based approach would dramatically speed up construction for two main reasons. First, the lightness of mass timber structures would require less extensive foundations. Second, the CLT and glulam cleat technology would make it easy for mass timber parts to snap into place quickly.

Sidewalk Labs believes the structural assembly of a building could ultimately reach speeds of one floor a day, compared with a typical on-site construction timeline of one floor per week. In other words, the basic structure for a 12-storey mass timber building could go up in as little as 12 days, compared with a more typical timeline of three months.

To complete a 12-storey building — which involves basic structural assembly as well as the installation of all finishes, the connection of all electromechanical equipment, and the execution of all tests — Sidewalk Labs estimates that its factory-based process can reduce construction time from 20 months to 13 months, delivering projects 35 percent faster than today's methods.

The advantages of assembly for mass timber exist at the scale of a single building but would likely increase over time, since construction workers would become more familiar with the cleat system and on-site managers would optimize the assembly sequence. These assembly innovations would also lead to a dramatically quieter construction site by removing the need for heavy equipment, eliminating material staging space, and reducing the number of on-site workers.

Sidewalk Labs does not plan to perform its own on-site assembly and instead proposes to work with local general contractors for this part of the process. Sidewalk Labs commits to reserve 10 percent of the hours spent on the construction of the neighbourhood for workers from historically disadvantaged and equity-seeking groups.

Improving productivity and worker conditions

Sidewalk Labs' plan for an off-site factory would result in a lower cost of construction and a faster completion time, both important steps towards helping Toronto reach new levels of affordability. But changes to the construction industry would have impacts on jobs and labour that must be taken seriously. While a new ecosystem of manufactured buildings would reduce total job hours for on-site construction crews, Sidewalk Labs believes that, on net, its approach to off-site manufacturing would have several benefits for construction workers in Toronto and across the region:

New, higher-paying jobs.
Though it would reduce on-site construction jobs, an off-site factory would increase job hours in factories and would create new jobs in related trades. Sidewalk Labs has explored these trade-offs with leadership of Ontario's Carpenters Union Local 27, who believe a new industry focused on mass timber could create new carpentry schools that teach workers to use engineered wood, leading ultimately to higher-paying factory jobs for this new specialty.

Additionally, the emergence of a mass timber factory in Ontario could bring about new local suppliers of timber as well as competing factories over time. Finally, by accelerating development within the IDEA District, a factory would catalyze an estimated 5.2 million total work hours for all factory-related trades.

Shorter commutes, greater comfort.
Shifting on-site construction jobs into factories has the potential to change the geography of labour across a region, a shift that comes with some notable advantages. Factory-based construction provides stability of commutes, since the job site never changes. Hours in factories are far more predictable. And unlike on-site construction jobs, factories are climate-controlled and well lit, with access to sanitation and lunch areas.

Safer work environments.
Labour statistics suggest an off-site construction factory would also improve worker safety. According to Ontario's Workplace Safety and Insurance Board, construction sites are considerably more hazardous for workers than manufacturing facilities. From 2013 to 2017, the WSIB recorded 4,499 claims from construction workers who lost time on the job due to injury. That amounts to 1,146 claims for every 100,000 construction workers, compared to only 641 lost-time claims for every 100,000 manufacturing employees (see table below).[46]

The safety benefits of manufacturing jobs

From 2013 to 2017, Ontario construction workers filed an average of 1,146 injury claims for every 100,000 workers, compared with 641 for factory workers.

	Construction	Manufacturing
Claims per 100,000 workers		
Lost-time claims	1,146	641
High impact claims	429	207
Fatalities	5.6	0.9

Note: All figures represent five-year averages. Manufacturing includes making, preparing, altering, repairing, ornamenting, printing, finishing, packing, packaging, inspecting, testing, assembling, and adapting for use or sale any article or commodity or raw material.

Achieving construction cost savings of 20% at scale

A factory-based approach to mass timber could reduce costs across typical construction categories, including material procurement, assembly, waste, and on-site workers. Realizing these savings requires a sufficient scale of development, such as the proposed IDEA District, both to produce a significant volume of building parts and to optimize factory operations.

	Share of typical project cost	Share of mass timber factory costs
Materials procurement Bulk purchases would limit the rising cost of materials and ensure predictable pricing.	30%	27%
Design A pre-designed library of parts would dramatically reduce overall design time and cost.	6%	5%
Assembly Easier on-site assembly of prefabricated mass timber parts would reduce project management costs and site operational costs during a shortened construction period.	14%	12%
Transportation A library of parts would enable optimized shipping, reducing transportation costs.	3%	2%
Waste Finishing parts in a factory would nearly eliminate on-site waste.	2%	1%
Labour Factory construction would reduce on-site construction needs, while increasing hours for factory workers and improving safety.	35%	26%
Contingency Greater supply chain reliability would reduce the need to build "contingency" costs into projects.	10%	7%
Total typical project cost	**100%**	**80%**

Accelerating development would catalyze an estimated 5.2 million total work hours for all factory-related trades.

Improving project predictability through pre-approved prototypes

Canadian code currently restricts mass timber buildings to a maximum of six storeys, given the relative youth of this technology. But mass timber has advanced rapidly. In the last five years, construction has begun or been completed on 21 timber towers above seven storeys worldwide.[47] Toronto has four tall timber buildings planned or in the works, including a 14-storey building at the University of Toronto and a 12-storey research and education centre at George Brown College called the Arbour.[48]

Additionally, the National Research Council, Canada's code body, may align with its equivalent body in the U.S., the International Code Council, in approving by 2021 an approach for timber buildings up to 18 stories tall. These provisions would include protections against fires, as already exist for other materials such as concrete and steel.

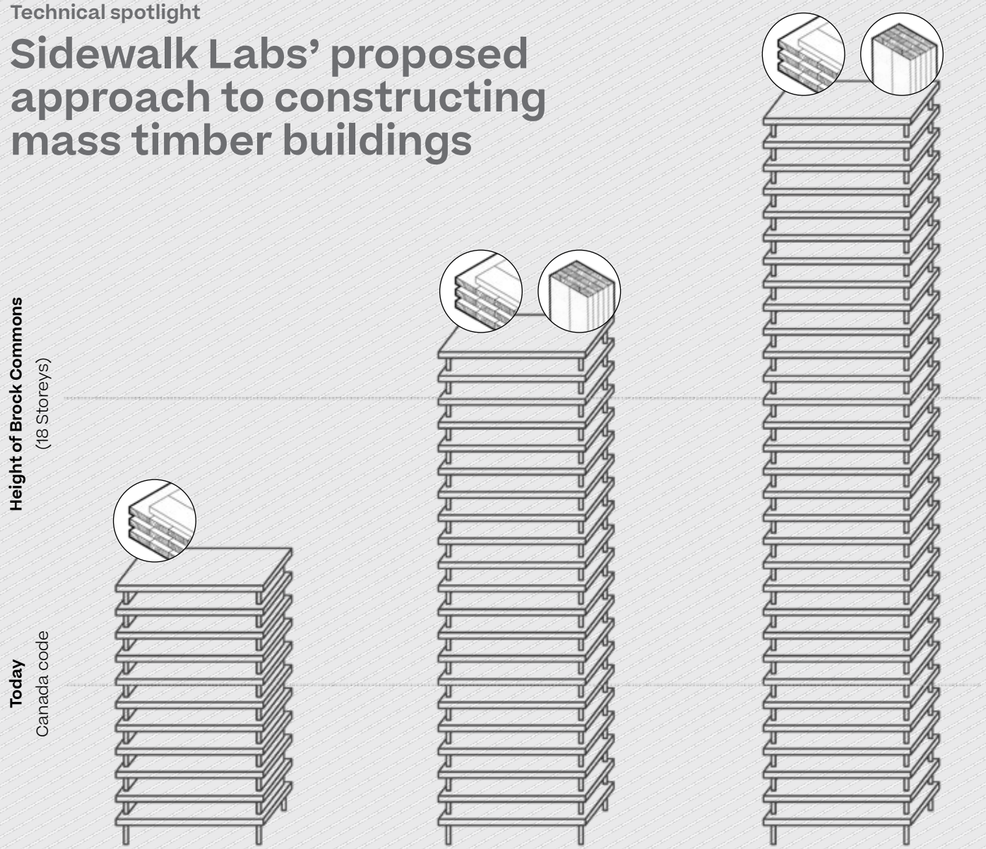
In Quayside, Sidewalk Labs proposes to create buildings up to around 30 storeys by filing for a common performance-based approvals pathway known as "alternative solutions," the approach used by Terrace House in Vancouver and being pursued by the Arbour in Toronto. Approval of this alternative solution involves submitting project-specific structural-engineering calculations and computer models to regulators, demonstrating how the building would perform as well as or better than the "acceptable solution" for conditions such as wind, rain, fire, and seismic activity.[49]

To enhance its filing, Sidewalk Labs plans to have its building designs peer-reviewed by independent evaluators, including the Vancouver-based Aspect Structural Engineers; Vortex Fire Consulting, a global fire-code consulting firm with offices in Toronto; and CHM, a fire-engineering consultancy with offices in Ottawa. Sidewalk Labs is also working with Equilibrium, a Vancouver-based structural engineering firm that was part of the team (along with CHM) that designed the Wood Innovation and Design Centre at the University of Northern British Columbia, an eight-storey, mass timber building completed in 2014.

After completing these approvals — and given the standardized components of the factory's library of parts — Sidewalk Labs anticipates that code reviewers and permit authorities could potentially identify pre-certified building components and assemblies, even for entire structures. For example, after a 10-storey CLT residential tower gained approval once, that same design could be "express" approved when applied to a new building project, with the architect or engineer of record responsible for confirming that the design has been used before.

Technical spotlight

Sidewalk Labs' proposed approach to constructing mass timber buildings



2–10 Storeys
Res – Loft 1/2/3

A self-supported tower prototype of around 10 storeys would be built using "three-ply" (or three-layer) CLT structural wall panels and five-ply floor plates.

The main advantage of CLT-only towers is that they are faster and less expensive to assemble than buildings that require interior posts and beams for structural support. Currently, a 10-storey building approaches the structural limitations of a three-ply and five-ply CLT system. To support buildings of taller heights, thicker CLT panels would be required, which would eat into usable square footage and create a more complicated and expensive structure.

10–20 Storeys
Res – Loft 1/2/3

A building prototype of around 20 storeys would be built using glulam beams and posts as the structural support system throughout the building.

Existing buildings, such as the 18-storey Brock Commons, have demonstrated the viability of mass timber construction near this height — although 20 storeys would top the existing record for Canada.

20–30 Storeys
Res – Loft 1/2

A building prototype of around 30 storeys would also be built using glulam beams and posts as the structural support system.

In 2019, Sidewalk Labs plans to begin designing a prototype of around 30 storeys called Proto Model X (or PMX) that would allow for testing and refinement of the library of building parts within Quayside. Delivering PMX would demonstrate the viability of integrating various technologies as well as the factory process. This work would require close collaboration with government partners to determine the necessary approvals for delivering a system of tall timber buildings, starting with Quayside.

Unlocking value and reducing contingency through overall project predictability

Factory-based construction techniques and a library of building parts would help developers accelerate project timelines and improve overall predictability. Sidewalk Labs estimates that 6 million square feet of delivery output would be needed to refine the factory process to a point of peak efficiency. This demonstration phase would also stabilize the operating margins critical to reducing developer risk.

With that period complete, Sidewalk Labs believes its proposed factory process would lead to improved project economics, enabling developers to clear returns while contributing to an ambitious vision for 40 percent below-market housing within the IDEA District.

A market analysis conducted by Sidewalk Labs anticipates that accelerating project timelines and reducing project risks would enable developers to create value by reducing contingency costs compared with current practices and by completing more projects over the same time period. In response to these benefits, developers might even choose to accept lower rates of return on any given project.

As described in the section of this chapter on housing affordability, beginning on Page 262, Sidewalk Labs estimates that factory-based construction techniques could unlock $639 million in value through 2048 when deployed at the full scale of the IDEA District. That value represents a sizeable contribution from developers toward below-market housing, which would complement government affordability programs to help Toronto achieve its goals for mixed-income communities.

Value unlocked for below-market housing:

$639 million

Factory-based construction enables developers to support an ambitious vision for 40% below-market housing.

Goal 3

Accelerating Construction Timelines

Coordinate the supply chain with a digital delivery system

To coordinate every part of the proposed mass timber supply chain, including the off-site factory line and on-site assembly, Sidewalk Labs plans to create a digital coordination system called Sidewalk Digital Fabrication.

Automobile manufacturers have long used integrated software systems to coordinate every stage of their production chains — from the factory in one place making hubcaps, to the regional assembly plant in another place putting all the pieces together, to the car dealership in yet another place selling whole cars on a lot. Car designers also get feedback from the product to make those cars both safer and better suited to consumers.

In the past 10 years, the emergence of similar software for buildings, known as building information modelling (or BIM), has helped organize the building process. BIMs can track essential details such as availability, price, material, weight, shape, strength, all the way down to the serial number of a given component. Just like the coordination systems for cars, BIMs create more reliable cost and time estimates, as well as a feedback loop for the supply chain to improve over time.

The proposed Sidewalk Digital Fabrication system would build on existing BIMs to create an end-to-end digital backbone for the entire construction pipeline, connecting suppliers, developers, architects, regulators, contractors, and even landlords.

An integrated software system for buildings, similar to those used by car manufacturers, can provide more reliable time and cost estimates.

A new digital system makes it possible to coordinate every part of the mass timber supply chain, from the factory to the construction site.

Lack of coordination among these groups is a big reason why construction costs are so unpredictable today. In a typical case, developers create a feasibility study for a plot of land — a lengthy, iterative process. Once that study is done, an architect typically integrates those ideas into an actual building design despite having little visibility into available construction supplies. From there, a contractor bids on the price of completing the job, which often means the architect must revise the designs to meet a budget. At that point, regulators would say whether or not the design meets approval; if not, it is back to the drawing board again. All of these hiccups add time and money to a project.

The Sidewalk Digital Fabrication system would aim to create an unprecedented degree of clarity across the entire development ecosystem, enabling all parties to reduce costs related to uncertainty.

The system would make site-specific details of a development process trackable in real-time, including factory parts, building designs, shipping statuses, construction-site management, and building operations. This integrated digital interface would provide instant feedback on how decisions impact capital costs, delivery timelines, operating performance (such as energy use), and other considerations throughout the planning process.

Sidewalk Labs plans to build the underlying infrastructure to support this advanced system but to partner with other innovative players in the field, such as Autodesk, which can provide other components of the planning platform, such as tools to estimate costs and procure materials.

Comparison

Improving the entire building supply chain

	Today	Sidewalk Digital Fabrication
Architects and designers	A lack of reliable manufacturing options encourages customization, driving up project costs and creating greater risk of delay. Design teams spend significant time coordinating and modelling a project-specific approach to building detailing; mechanical, electrical, and plumbing integration; fire performance; and acoustic performance — just to have the designs modified after bidding and the engagement of suppliers and contractors. Lack of insight into parts and costs leads to projects that are over budget. If costs must be cut late in the process, the original vision might get sacrificed.	A library of building options — with real-time prices and delivery times shown through the BIM interface — would enable architects to create designs with certainty about what supplies are available. The variation of these materials would also facilitate design excellence. Additionally, a new BIM module could enable architects to rapidly evaluate computer-generated design options and balance planning decisions with their creative vision.
Manufacturers	Customized building designs make it difficult to create parts ahead of time and in sufficient volume to reduce costs.	Feedback from a BIM could ensure that a factory created a consistent supply of standardized building component types, thus also offering pre-determined delivery timelines. This coordination would ultimately lead to more efficient operations, more predictability, and reduced costs.
Contractors	Customized designs make for a less standardized assembly process.	BIM systems can help contractors know how best to assemble the parts in a given design. Additionally, the standardization of parts would help workers assemble them easily and quickly, particularly as crews gain more familiarity with the standardized components.
Regulators	Customized designs introduce uncertainty about whether building elements will meet code or require costly alterations. A code authority reviews designs for the first time and issues permits and approvals late in the development process. If a reviewer identifies certain aspects of a plan that fail to meet code, architects and contractors must often go back to the design and procurement phase, potentially adding months to a project timeline. Additionally, code authorities are sometimes overwhelmed by the volume of applications from developers and the amount of manual work and background research required to respond. That can lead to delays in the permitting process, which in turn adds time and cost to projects throughout the city.	Code reviewers and permit authorities reviewing a BIM model could identify pre-certified building components and assemblies. This process would free architects and engineers to choose from a kit of parts with confidence that their final designs and plans will meet code and require minimal permit review. For example, after one 10-storey CLT residential tower has been approved by the buildings department, that same design could be “express” approved when applied to a new building project, with the architect or engineer of record responsible for confirming that the design has been used before.
Landlords and tenants	Customized designs make it difficult, time-consuming, and costly for landlords or tenants to replace or maintain outdated building elements.	Landlords or tenants could easily maintain and operate buildings because any replacement parts would be well documented in the digital system and available via continual supply. For example, it would be easy to find out where a broken window came from and order a new one.

Ch–3

Part 2

Helping Neighbourhoods and Households Evolve

Key Goals

1
Create an adaptable "Loft" space built for all uses

2
Accelerate renovations with a flexible interior wall system

3
Enable a safe, vibrant mix of uses with real-time building codes

4
Design affordable and flexible housing units

New construction techniques represent a first key step towards faster development and more affordable neighbourhoods. But a comprehensive plan for affordability must also design building structures with flexibility and adaptability, features that can enable a complete community of residents, businesses, and workers.

Today, most spaces within a building are created for a single purpose: residential, commercial, or industrial, with perhaps a little retail on the ground floor. Adapting these spaces to accommodate new uses requires lots of time or money. Yet the needs of cities, local economies, and households evolve over time, and rigid building designs are a barrier to meeting them.

To help neighbourhoods evolve, buildings should be able to accommodate a range of uses and shift quickly and inexpensively from one need to another. The result would be communities where people can live, work, shop, and socialize within a short walk. Residents could visit cultural installations without a car or take lively nighttime strolls past buzzing parks and restaurants. Within a single neighbourhood people could find affordable space to pursue their professional dreams, whether a single co-working desk to plot out a startup or a short-term stall to sell a hand-crafted confection. Homes could meet the needs of growing families and single-person households alike.

Adaptable spaces also enable a community to respond more effectively to larger trends. Right now, high-demand cities like Toronto need as much housing as possible, but at other moments in time they have needed industrial or office space with equal urgency. Looking ahead, retail spaces are on the verge of transforming in the face of e-commerce. When a space can be used for many different purposes, or when it can be renovated for any new use at a low cost, it is unlikely to remain vacant for very long.

Sidewalk Labs' plan to create buildings that can actively support communities over time has four core components.

A loft-style, adaptable approach to floor plans and interior spaces could be adapted for many different types of residential and non-residential uses. A flexible wall system would enhance this approach by dramatically accelerating interior renovations. A real-time building-code system could ensure consistent safety levels even as a building changes its mix of tenants. And housing units of all sizes designed for peak efficiency could provide affordable options and flexibility for all types of households.

At the neighbourhood scale of Quayside, Sidewalk Labs plans to build approximately 350,000 square feet of adaptable space to demonstrate this design's ability to accommodate residential, commercial, and other uses within a single structure. Sidewalk Labs estimates that this adaptability would reduce the time required to convert individual spaces by an estimated 50 percent. In collaboration with the city, the real-time code system would also be tested in Quayside for its ability to detect nuisances in real time. Using an efficient approach to unit design, Sidewalk Labs plans to make 40 percent of all housing units family sized (two bedrooms or more).

Adaptable spaces would reduce renovation time by
50%

Implemented at the full scale of the IDEA District, Sidewalk Labs' adaptable building innovations could be extended across hundreds of spaces, providing a dynamic new model of mixed-use development that can keep pace with a community's evolving needs. For the first time, cities would be able to know in real time that buildings are meeting safety codes, enabling a far greater mix of uses than typically found today. And an efficient approach to unit design would enable developers to create more overall units while retaining liveability, unlocking new value that could help meet the ambitious goals of affordable and below-market housing programs.

Flexible buildings enable a dynamic new model of mixed-use development that can keep pace with a community's evolving needs.

Goal 1

Helping Neighbourhoods and Households Evolve

Create an adaptable "Loft" space built for all uses

Toronto has many examples of the adaptive power of buildings with vast open floor plates, known as lofts.

Take the King Street West neighbourhood, once home to thriving manufacturers and warehousing facilities that served the city through World War II.[50] As these operations began to decline, many buildings fell into neglect, only to be revived and adapted in recent years into new homes, office spaces, shops, and restaurants — uses far different from the neighbourhood's industrial roots. But while these industrial structures proved nimble enough, adapting building spaces to dramatically different needs is generally expensive.

To reduce the cost of renovating spaces while retaining the spirit of industrial loft structures, Sidewalk Labs has designed an adaptable building space called, simply, Loft.

Sidewalk Labs' Loft concept improves upon traditional loft buildings by planning explicitly for ongoing, more frequent interior changes around a strong skeletal structure (sometimes called "good bones"). Lofts are designed around a post-and-beam skeleton and feature high ceilings as well as a flexible wall system to make renovations fast and easy.

This combination of a durable exterior with a nimble interior enables buildings to remain flexible throughout their lifecycles, accommodating a wide range of uses — including residential, retail, production, community, office, hospitality, and parking — that can respond quickly to evolving needs.

The basic idea behind Loft is to overbuild the "bones" of a building to allow for unanticipated uses in the future. A physician's office that needs a lot of interior rooms, a retail showcase that needs few interior rooms, and an artist studio that needs high ceilings could all occupy the same space over time, instead of having to find separate building spaces designed to fit their needs. That flexibility means Lofts would be more expensive to create up front, but it would also help the spaces recover these costs over time by decreasing vacancy periods by 50 percent compared to traditional spaces. If turnover of a typical space takes four weeks, adaptable space would decrease that period by about two weeks by removing time-consuming activities, such as demolishing partition walls and moving electrical wiring (see Page 246 for wall renovation comparisons). Sidewalk Labs estimates that after roughly two tenant turnovers, the initial cost of Loft would break even.

In addition to facilitating tenant changes, Loft spaces would make it easy for tenants to adjust their own spaces, thanks to reusable interior fittings such as interior walls. For example, a company could reconfigure a Loft office space to accommodate a weeklong training seminar, then return it to offices or small conference rooms. Likewise, a family might decide to subdivide a room in a Loft housing space to accommodate a long-term guest or new family member. Beyond saving time, reusable interior fittings also cut down on construction debris.

At the core of this flexibility is a system of standardized dimensions and modular interior parts that enable buildings to be reconfigured rapidly from one use to the next. This technical foundation includes: high ceilings, long floor spans, modular fittings, utility cavities, and prefabricated wetboxes. (See the next page for more.)

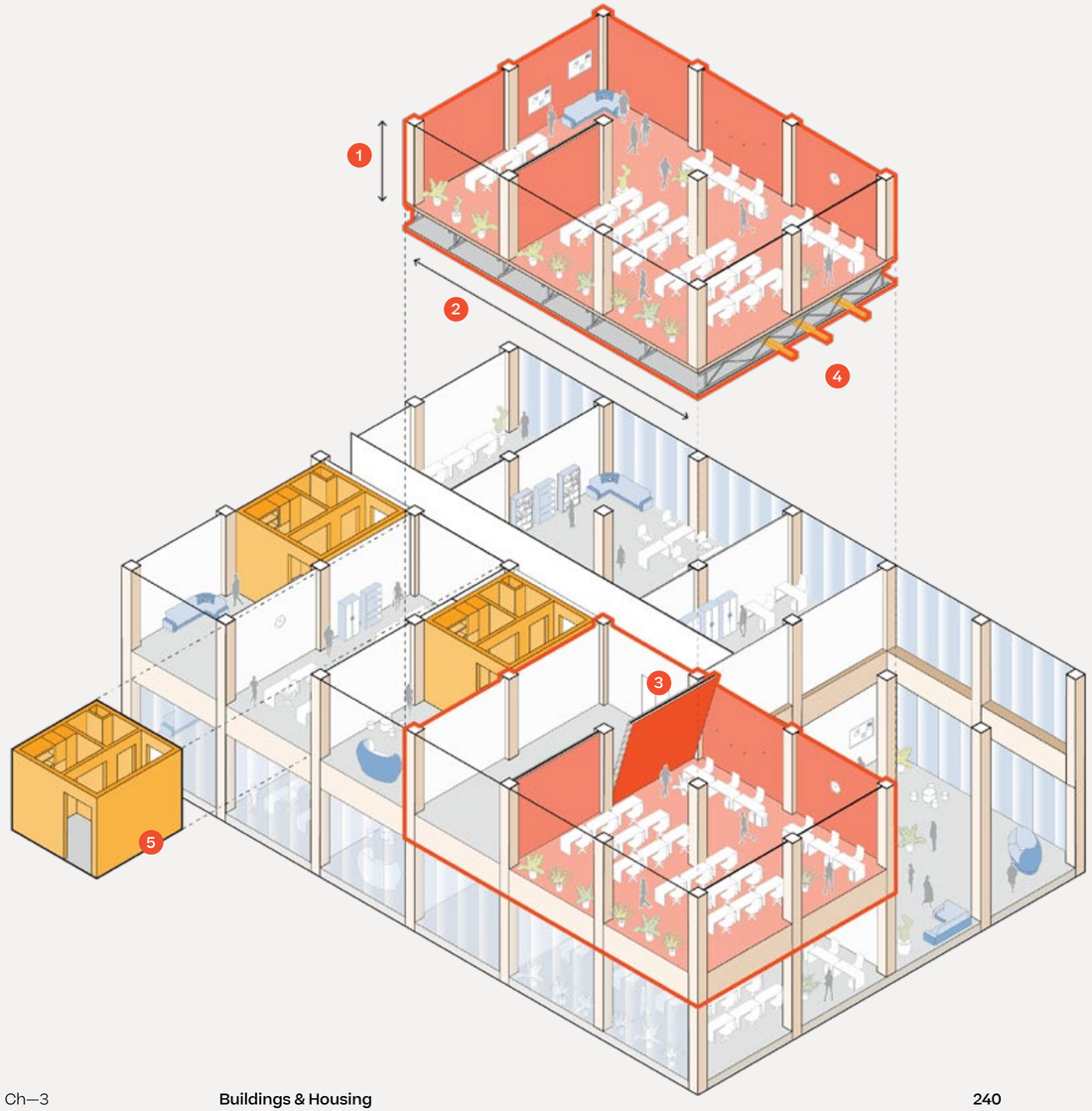
To reduce renovation costs while retaining the spirit of industrial loft structures, Sidewalk Labs has designed an adaptable building space called, simply, Loft.

In Quayside, roughly 10 percent of building square footage would be Loft space. In an effort to diversify spaces vertically, Quayside's buildings would incorporate Loft spaces from the 3rd to the 12th storeys. Loft spaces would begin as a combination of residential, commercial, office, and light industrial tenants. Over time, they would have the ability to shift across these uses in response to neighbourhood needs.

One reasonable concern with flexible spaces such as Loft is that they would all immediately shift towards the area of greatest market demand. For example, if developers converted all Loft spaces in Quayside to housing, that outcome would indeed respond to current local needs, but it would also undermine the larger goal of creating a live-work neighbourhood. For that reason, Sidewalk Labs plans to implement minimum targets on its Loft spaces for commercial usage, so they always reflect some level of mixture across commercial and residential uses.

Loft's five flexible design features

By incorporating high ceilings, long floor spans, modular fittings, utility cavities, and prefabricated kitchens and bathrooms, adaptable Loft spaces can be renovated in half the standard time. This flexibility can accommodate a lively mix of homes, shops, offices, and other uses to help a community meet its evolving needs over the short and long term.



1 High ceilings.
At roughly four metres, Loft ceilings are taller than usual to create sufficient space for a variety of interior uses, such as art studios, small businesses with lots of inventory storage, or smaller apartments that feel more comfortable with higher ceilings.

2 Long floor spans.
At 27-by-33 feet, with few columns interrupting the space, Loft floor spans would provide for the flexible arrangement of spaces and make it easier to subdivide the same space for new uses.

3 Modular fittings.
Loft's flexible interior walls (described in detail on Page 246), doors, finishes, and other modular fittings would be designed to be reusable and interchangeable across all uses.

4 Utility cavity.
By placing utilities in a cavity beneath the floor plate, Loft would create an independent home for water, electrical, lighting, ventilation, fire suppression, and heating and cooling systems, among others, enabling renovations without needing to rip out utilities and reinstall them every time.

5 Prefabricated wetboxes.
Loft is designed so that the bathroom and kitchen sub-components arrive as boxes that can be easily slotted into a building's structure during assembly and quickly connected to all utilities.

In addition to featuring long-term Loft spaces throughout buildings, Quayside would also pilot two specific applications of the concept: a lower-floor flexible space called "stoa," and a future-proof parking structure.

Loft application

Stoa: A flexible new ground floor

Much like buildings themselves, today's ground-floor spaces tend to be pre-defined for specific purposes. A barber shop needs very little storefront: just a door and a glimpse of a haircut. But a department store needs a long series of windows to attract customers with a variety of merchandise. Those specific designs make it very hard for landlords to fill retail vacancies and for business owners to contract or expand in response to changing economic conditions, such as the rise of e-commerce.

To improve the flexibility of ground-floor space, Sidewalk Labs plans to apply an adaptable structure to the lower two floors of its buildings called "stoa," taken from the lively open markets of Ancient Greece. Stoa spaces would be supported by large glulam posts spaced 12-to-18 metres apart to create long open stretches that could be divided into a variety of retail, production, or community spaces, according to neighbourhood needs. These spaces could be separated or combined to meet a variety of uses: one stoa stall might form a barber shop, while many stalls together could form a department store.

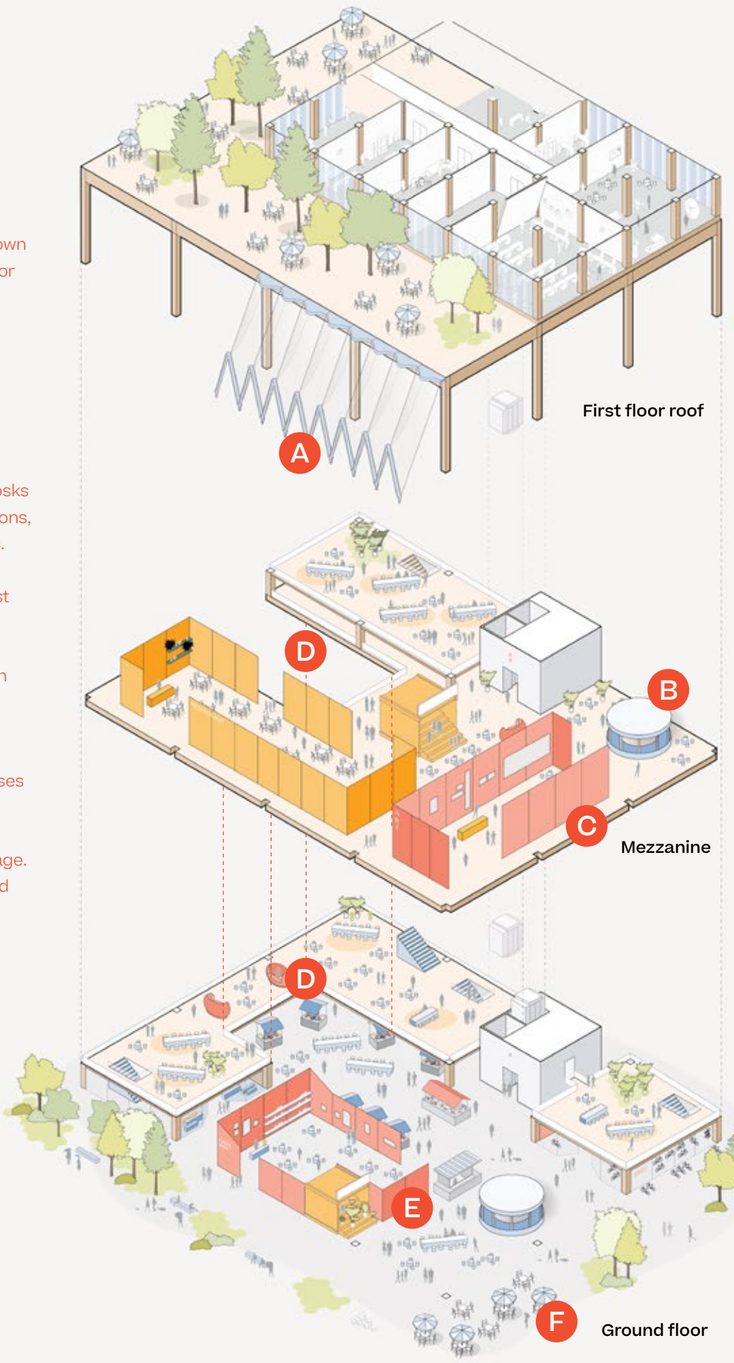
For retail tenants in particular, the cost of a launch would be significantly reduced in a stoa stall compared to a typical ground-floor retail space. In traditional retail spaces, tenants face high launch costs regardless of the length of a lease. Because stoa spaces are designed for more frequent turnover, tenants would incur a fraction of the launch costs up front and could make a return on their investment in a matter of months, rather than years.

Sidewalk Labs estimates that costs associated with structural and mechanical elements of renovation, such as moving walls and electrical wiring, would decline by roughly 50 percent. So if it would typically take a landlord $40 per square foot to conduct these aspects of a renovation, it would instead only take $20 per square foot. In addition, tenants who choose to take full advantage of prefabricated components and finishings could reap addition cost savings.

In addition, renovating a stoa space would be an estimated 50 percent faster than renovating a typical space, leading to less time between tenants, and thus to more vibrant communities. For example, companies with different peak seasons — a tax preparation firm, a costume store, a ski shop, and so on — could occupy the same stoa stall across the year.

See the "Public Realm" chapter of Volume 2, on Page 118, for more details on stoa.

Sidewalk Labs' stoa ground-floor space would be designed for fast, affordable renovations, enabling a lively mix of traditional retailers, small businesses, makers, community groups, and more, as well as a mix of short-term, seasonal, and long-term uses.



First floor roof

A **Weather-mitigation structures** (such as the building Raincoat shown here) can help to keep ground-floor spaces vibrant in all seasons.

Mezzanine

B Stoa provides spaces for **unique modular retail setups**, such as kiosks that can host temporary installations, supporting a dynamic mix of uses.

C A **flexible wall system** enables fast and affordable renovations that support the growth of businesses over time and help stoa adapt with changing neighbourhood needs.

D **Double height spaces** help stoa accommodate a wider range of uses than typical ground-floor spaces, such as art studios or small businesses with lots of inventory storage. These heights begin on the ground floor and can extend through the mezzanine area.

Ground floor

E Seamless **indoor-outdoor connections** help to break down the barriers between ground floors and sidewalk spaces, increasing vibrancy and interaction.

F Stoa space facilitates the launch of **small-scale pop-up shops** and other short-term initiatives that activate the ground floor.

Loft application

Flexible parking garages for a self-driving future

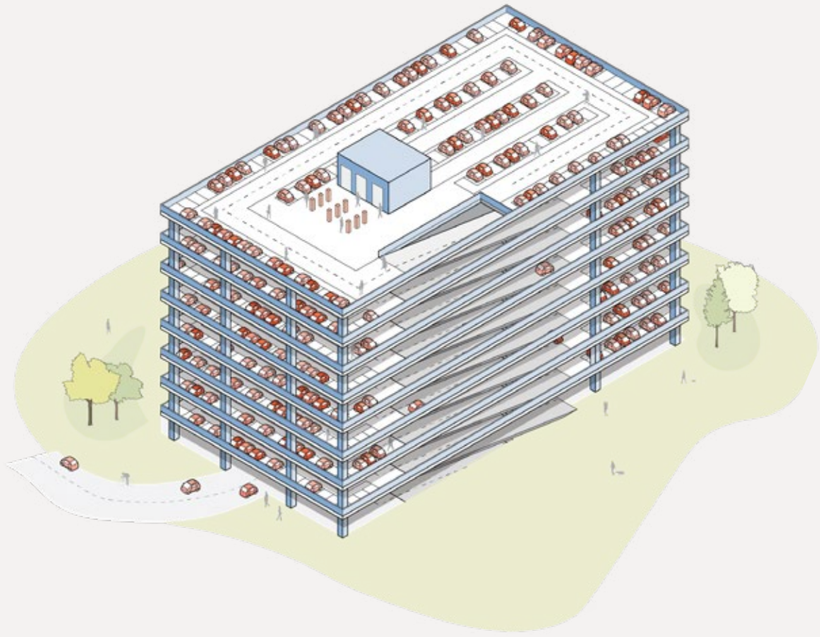
As described in the “Mobility” chapter of Volume 2, the arrival of self-driving vehicle fleets would mean neighbourhoods need fewer parking garages over time. But traditional parking garages are difficult to adapt to new uses given the inclines of their interior ramps and the orientation of their elevators, which tend to be along their perimeters. In conventional buildings, elevator shafts are placed in the centre for shared access.

Sidewalk Labs has developed a design approach for a Loft-style parking garage that can accommodate a reduced need for parking over time — without demolishing the entire structure. While an adaptable parking garage is not a fit in a small neighbourhood like Quayside with very little on-site parking, Sidewalk Labs plans to explore the potential for such a structure within the IDEA District.

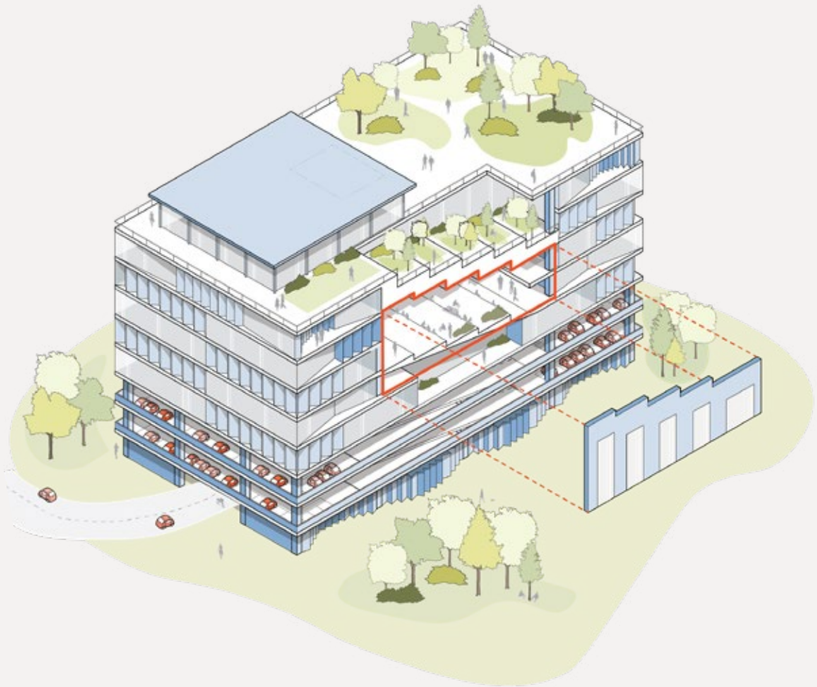
This design approach would put a majority of the parking space above ground, realizing $5.2 million in construction savings against a traditional 30,000-square-foot below-ground garage. To ensure flexibility of this design, ramps would be placed at the perimeter of the garage for easier removal or unobtrusive conversion. The elevator cores would be in the centre to accommodate an unknown mix of future uses. Stairway capacities and locations, as well as HVAC systems, would be suited to commercial or residential needs in anticipation of future conversion.

If the demand for parking did diminish, the conversion to an office or residential use could occur quickly and would incur a $8.6 million investment, much less expensive than building an entirely new office or residential building with the same capacity. This conversion would allow a building to continue generating revenue from all of its spaces, rather than getting stuck with a vacant parking garage.

Initial design
Before self-driving vehicles



Future adaptation
Once self-driving vehicles arrive



How a flexible parking garage can evolve over time

Underground parking would represent a sunk cost if demand diminishes due to the arrival of self-driving vehicles that reduce the need for car-ownership by operating as a shared-ride service. Sidewalk Labs’ adaptable design would feature only above-ground parking that could be easily repurposed in the future.

Such a parking structure, whether stand-alone or integrated within a commercial or residential building, could allow for a building’s investment to be adapted for other uses.

For example, with adaptable design of ramps and cores, a parking garage could be converted into an office or another use — instead of demolished and rebuilt at much higher cost — if parking demand declined in the future.

Goal 2

Helping Neighbourhoods and Households Evolve

Accelerate renovations with a flexible interior wall system

The rigidity of interior wall panels presents one of the biggest barriers to building renovations today. Demolishing drywall, moving electrical wires, reconfiguring sprinkler systems, and other common renovation requirements can take months and cost thousands of dollars, leading to long vacancies that take an apartment or storefront off the market, and making it hard for small businesses to compete.

Renovations are also rarely straightforward. Renovation workers almost always run into surprises, from the detection of incorrect wiring to the discovery of mold or asbestos, adding time and money to the process. It is not uncommon for adjacent tenants to get so annoyed at a lengthy renovation next door that they, too, leave a building. On top of these impacts, renovation involves knocking down drywall that ends up in landfills and churning up dust that reduces indoor air quality.

To tackle this challenge, Sidewalk Labs plans to create a flexible interior wall system that would enable adaptable Loft spaces to change within weeks instead of months, at a cost of hundreds instead of thousands of dollars, compared with traditional renovations.

These factory-produced, floor-to-ceiling interior walls would be 10 centimetres thick and made from timber panelling, with an acoustic insulation that would, according to standardized acoustical testing, make them as sound-resistant as conventional walls. Taken as a unit, this wall system would be easy to mount, move, or replace, helping building owners reduce vacant space, tenants alter space to fit business needs, and communities avoid lengthy disruptions to storefronts.

In addition to flexible walls for Loft spaces, Sidewalk Labs also plans to build flexibility into permanent interior walls in residential units, enabling them to expand (or contract) in response to resident needs. These walls would be designed with a flexible opening embedded in the wall. For example, if a family expands, a panel insert could be removed to create a new passage between rooms. The same panel could be reinserted if the additional room is no longer needed. Either process would take roughly half a day. (More on flexible units on Page 253.)

To ensure this flexibility, Sidewalk Labs also proposes new approaches to power systems and fire suppression protections, two of the biggest existing challenges to faster renovations.

Incorporating low-voltage power systems

Today, moving electrical wiring is a lengthy process, because most wires are protected in steel or corrugated plastic conduits and embedded in walls to reduce the risk of fires. Roughly 37 percent of all fires in Toronto are a result of electrical malfunction or cooking fires, with multifamily buildings experiencing a higher incidence of fatalities due to such events, according to Toronto Fire Services.[51]

Sidewalk Labs plans to design a low-voltage (under 2,000 watts), digital, electric power system that can travel over ethernet cables hidden under the baseboard or crown molding of flexible interior walls. Compared to electrical wires embedded inside walls, this system would dramatically reduce the risk of fires as well as the length of renovations. (To address cooking fires, Sidewalk Labs has proposed alternatives to natural gas that would result in cooking appliances being powered electrically.)

See the "Sustainability" chapter of Volume 2, on Page 296, for more details on electrification.

Power-over-ethernet is a controlled system that only sends power when a receiving device is active on the other end, unlike electrical outlets today, which receive a continual stream of power whether or not a device is active. That makes it possible to eliminate the cost of building a traditional "breaker box," which typically is needed to de-energize a wall plug or light fixture when there is a malfunction. It would also save closet space where breakers are usually stored. Sidewalk Labs will initially include provisions (such as converter boxes) to support appliances designed for AC power systems.

In addition to reducing fire hazards, power-over-ethernet capabilities enable buildings to eliminate electricity meters, since the same cable that carries the power can track electricity data down to the level of an outlet. This advance makes it possible for tenants who share a space — for instance, a co-working space, or even roommates — to receive individual electricity bills, encouraging energy efficiency.

Implementing mist-based fire protection systems

Conventional sprinkler systems represent another major barrier to faster interior renovation. Typically, fire sprinkler systems embed one-to-two-inch pipes in ceilings and walls. To move this type of system requires draining the pipes, opening the walls, unscrewing the piping, re-plumbing the connections, refilling the system, and checking for leaks. It can cost thousands of dollars per move.

As part of its interior wall system, Sidewalk Labs plans to incorporate a mist-based fire protection system that can be hidden along a wall surface or ceilings in one-centimetre (three-eighth-inch) tubing, reducing renovation time to less than an hour while improving fire protection.

Mist-based fire systems originated with the shipping industry as a way to fight vessel fires using just 10 percent of the water volume of traditional sprinklers. Museums and historic buildings later adopted them to cause less water damage to the art and historic architecture.[52]

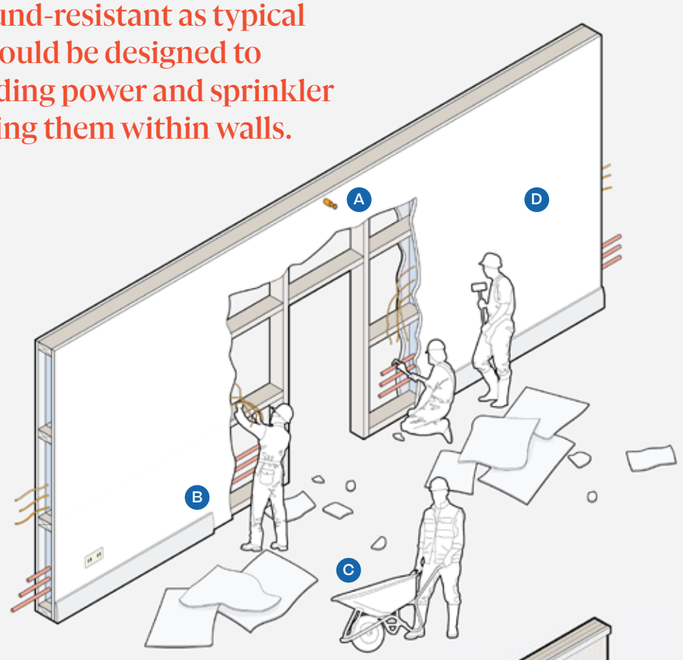
Continued on Page 250

Renovation that saves time and money

While just as strong and sound-resistant as typical walls, flexible wall panels would be designed to accelerate renovation by hiding power and sprinkler systems instead of embedding them within walls.

Residential

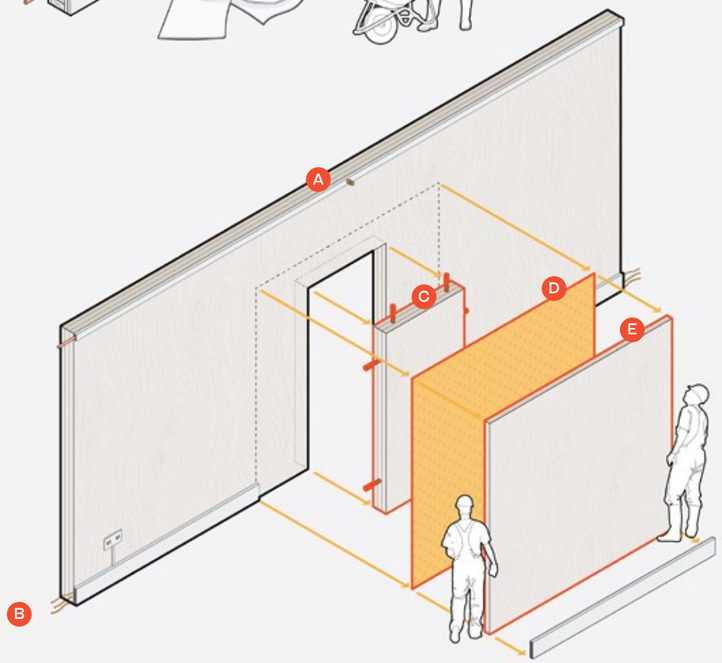
Traditional wall



- **A** Sprinkler pipes (2.5 to 5.1-centimetres) embedded in ceilings and walls require draining the pipes, opening the walls, and unscrewing the piping, re-plumbing the connections, refilling the system, and checking for leaks.
- **B** Access to embedded utilities requires drywall to be removed.
- **C** Plasterboard and wiring in partition walls creates waste during demolition.
- **D** Two iterations of spackling and sanding are typically required to produce a smooth surface ready to paint.

Residential

Flexible wall



- **A** Mist systems in one-centimetre tubing are hidden along a wall surface or ceiling and could be easily moved in less than an hour.
- **B** Removable baseboards hide systems, including a low-voltage digital, electric power system.
- **C** Removable panels close interconnecting spaces.
- **D** Additional soundproofing is included.
- **E** Architectural panels hide removable panel seams, and do not require spackling or sanding.

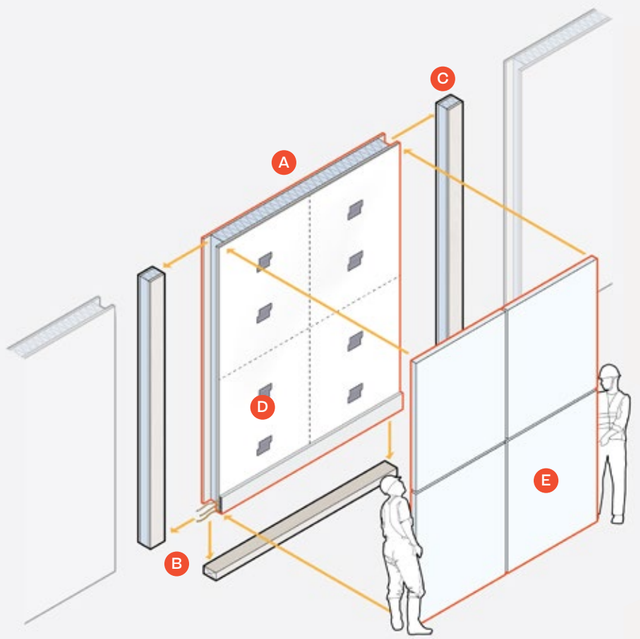
Commercial

Traditional wall

- **A** Electrical wires protected in steel or corrugated plastic conduits are embedded in walls and must be roughed into the correct placement.
- **B** Installation of drywall requires coordination among carpenters, electricians, and finishers.
- **C** Wall frames make buildings inflexible; full wall demolition is required, including removal of electrical wiring, sprinkler systems, and other components embedded in wall systems.

Commercial

Flexible wall



- **A** Loft's flexible interior wall systems could allow for walls to be removed as a panel from mounts, rather than demolished.
- **B** Low-voltage power systems are surface-mounted.
- **C** Walls have support structures.
- **D** Clip system allows for tenant to apply finishes.
- **E** Finished panels are chosen by tenant.

Continued from Page 247

In a traditional sprinkler system, water floods out like a hose, causing a lot of the water to fall below the fire before it is able to absorb heat. In mist-based systems, water is sent through a high-pressure (70 bar) nozzle that disperses the droplets into a layer of fine mist. This approach effectively acts as a vapor blanket that starves the fire of oxygen, snuffing it out. The reduced water quantity of the mist system makes it easier to clean up extinguished areas, thus preventing the water damage associated with traditional sprinkler systems. A low flow of water can also be delivered through tubing that is easily concealed in the interior finishes of buildings.

While mist systems initially cost more than traditional sprinklers, they recover these costs over time through their ability to improve wall flexibility and accelerate renovations. In Canada, three mist systems have been approved thus far, including one in the Credit Valley Hospital in Mississauga.[53] Quayside would be the first development in Toronto to use such a system in a neighbourhood of new buildings, demonstrating the potential for this technology's wider adoption.

Mist-based systems use

10%

of the water volume of traditional sprinklers.

Compared to electrical wires embedded inside walls, low-voltage power would dramatically reduce the risk of fires.

Goal 3

Helping Neighbourhoods and Households Evolve

Enable a safe, vibrant mix of uses with real-time building codes

The prospect of buildings that contain a shifting mix of residential, commercial, and industrial spaces creates the need for new tools capable of ensuring all tenants can not only coexist safely, but also thrive.

For most of the 20th century, cities separated residential, commercial, and industrial uses geographically to protect homes from noise, air pollution, and other nuisances.[54] This approach of "single-use zoning" made sense in a world without reliable tools to monitor the environmental nuisances of commerce and industry. But it also discouraged an active mix of home, work, and retail spaces in the same neighbourhood — let alone the same building.

Meanwhile, the modern economy has blurred the lines of traditional uses. Should a tech startup that launches in a spare bedroom be viewed as a home or an office? Should the studio of a craft maker creating wares for an e-commerce site like Etsy be viewed as a home or an industrial space? People in cities want not only to live in places with a mix of activities but also the ability to change those activities at a rapid pace.

To enable a vibrant mix of uses while still protecting quality of life, Sidewalk Labs proposes to require a digital building code system that can measure the impacts associated with a shifting mix of building uses in real time. Designed with inputs from city government, Sidewalk Labs' proposed building code system would monitor interior spaces in a non-invasive way for noise, air pollution, and other nuisance levels.

The proposed system would be operated and managed by the building owner, and enforced by the City of Toronto, in full accordance with the standards established by the city.

In Quayside, Sidewalk Labs proposes a pilot of this system, with the city able to monitor the performance of a building using the system's real-time data. For example, if a building registered a noise level that exceeded a code standard, the landlord and city would be notified of the violation.

At full scale of the IDEA District, provided the system's value is demonstrated in Quayside, it could be used to grant permits based on proposed building uses instead of based on prescribed land uses, enabling communities to pursue a greater mix of live-work buildings and local economic activity.

A system based on “outcomes”

Sidewalk Labs’ proposed real-time code system would be designed around the premise that buildings should be able to house a diverse range of tenants — residential, commercial, and light industrial alike — so long as everyone adheres to the building’s rules. For example, if a mom-and-pop craft jeweler does not use noxious chemicals or make loud noises, there is no reason it should have to be located in an industrial area. In other words, it is the *outcomes* that matter most, not the *uses* that define traditional zoning.

By setting an “outcome-based” standard, a real-time code system can better protect all uses and support a broader mix of uses at the building and district scales, including the integration of production spaces and small-scale industries within a residential and commercial building or neighbourhood.

Toronto’s existing building codes have distinct standards for 25 different uses. In 2018 and early 2019, Sidewalk Labs and code experts worked together to identify nine code categories whose anticipated outcomes are similar enough to be condensed into a single, flexible “use-neutral” category, such as restaurants, single-dwelling units, mercantile/retail, low-hazard industrial, and more.

Any use covered under this integrated “use-neutral” category would be allowed to occupy a building, provided the tenant adheres to the building regulations — the outcomes.

To enable this new diversity of uses while protecting quality of life and public safety, this outcome-based system would monitor several types of building regulations on an ongoing, real-time basis via environmental (non-personal) sensors. These devices would be placed in building hallways to collect information on structural integrity and vibration, interior air quality, and noise levels. For example, a strain gauge sensor in a floor slab would be able to detect structural integrity issues in cases where individual building occupants place undue loads on floors.

(These systems would not replace the need for standard building sensors, such as fire detectors.)

This proposed system would be designed to collect only the specific information pertaining to building codes, without the ability to capture any personally identifiable information, in accordance with Sidewalk Labs’ proposed Responsible Data Use Guidelines. To encourage further innovation around building uses by government officials, researchers, and other third parties, access to this non-personal and aggregated data would be made publicly available in real time under the terms of the proposed Urban Data Trust.

Partnered with proper enforcement, real-time monitoring would create a responsive code system that would protect neighbourhood safety while enabling buildings to include a far more diverse array of homes, shops, and workplaces than typically found today.

All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the “Digital Innovation” chapter of Volume 2, on Page 374.

Goal 4

Helping Neighbourhoods and Households Evolve

Design affordable and flexible housing units

Innovations that enable faster construction and more adaptable buildings also have the potential to unlock housing design that better meets the needs of modern families and can evolve with changing household types. In Toronto, as in many cities, housing options for downtown living currently fall short for many groups, and a number of economic and social trends suggest that traditional ways of designing downtown apartments need to change to keep pace with demographic shifts.

A mobile workforce values the ability to follow job opportunities, and find lean housing options, in new cities. Growing families and downsizing empty nesters who might once have chosen (or remained in) the suburbs are willing to trade space to live in the city for its diversity, amenities, and culture — if they can find apartments the size they need, and provided they can retain a sense of community. Also, many households are embracing the rise of sharing services, reducing their need for storage space.

In cities around the world, new housing innovations have emerged to address these trends and keep a more diverse set of people living downtown (see sidebar on Page 257), including the rise of “micro-units” (smaller units that rent for less while remaining livable through efficient design) and co-living programs (which feature shared building amenities, such as communal kitchens, to enhance community while keeping rents lower).

Building on these global trends, Sidewalk Labs plans to offer a set of efficient, ultra-efficient, and co-living units designed to deliver housing that is flexible enough to meet these changing social needs, but still affordable. To ensure that the full Quayside program supports the needs of families, 40 percent of all units would be sized for families, with two bedrooms or more.

Quayside’s housing program is designed to accommodate households of all sizes

	Studio	One-bedroom	Two-bedroom	Three-bedroom	Four-bedroom	**Total**
Percent of proposed housing program	20%	38%	28%	11%	3%	**100%**

The transition to smaller units is made possible without sacrificing comfort, through thoughtful space-saving furniture; flexible walls that enable households to contract or expand with greater ease than currently found in apartments or condos; shared building amenities, such as communal eating spaces or co-working spaces; and sufficient access to neighbourhood-enhancing amenities, such as on-demand storage delivery and an extensive public realm.

Together, these new unit designs can make dense urban living more appealing — and affordable — to a wider group of people, including the singles, seniors, and multi-generational families who make up a growing percentage of the Toronto population.

Efficient and ultra-efficient units

Sidewalk Labs' proposed efficient and ultra-efficient units would be designed to make the most of their space. They would exist at a range of bedroom sizes — all the way up to four bedrooms — and cross all income levels. (These proposed options would exist in addition to proposed "standard" units that are comparable in size to existing downtown developments but designed more efficiently as well.)

Building on global research by nArchitects, Sidewalk Labs conducted initial design explorations on efficient units with three local architecture firms: gh3, Dubbeldam Architecture and Design, and Teeple Architects. This work surfaced a set of design features that would enhance the liveability of smaller units (see studio image). Using these concepts as a starting point, Sidewalk Labs plans to continue refining specific unit designs to best match market and community needs over time.

Multi-purpose furniture pieces.
Sidewalk Labs plans for its units to include efficient furniture designed to maximize space and create space for something else when not in use. Examples include multi-purpose benches on height-adjustable rails that can double as desks or shelves; convertible beds that can be configured into a couch or folded up to free up floor space; and fold-down tables. For example, in the gh3 studio concept featured here, the movable desk and flip-down table can free up an additional 9 square feet of usable space.

See the "Mobility" chapter of Volume 2, on Page 22, for more details on neighbourhood delivery.

On-demand storage.
The proposed efficient units would be designed with less in-unit storage space than a market comparison apartment design. But the efficient units would compensate in two ways. One is the availability of free in-building storage. This would enable families to store weekend recreation items, infrequently used kitchen items, or that special suit or dress.

Second is the availability of low-cost, on-demand delivery from off-site storage facilities located nearby. This service would make it easier for households to store items they seldom use — such as seasonal clothing, holiday items, or skis — outside the apartment. An underground delivery network linked into all residential and commercial buildings would ensure that residents could access their items quickly and at any time.

Spatial quality.
High-quality living in small downtown spaces requires innovative spatial designs. The gh3 units described here would be designed with tall ceilings (2.7 metres) to increase daylight penetration within the units and also allow for more vertical storage space — basic enhancements that do not significantly erode the cost basis for developers. They would also locate all bedrooms on an exterior wall with a window (no longer a common feature in new Toronto development). Finally, these units could reveal the mass-timber construction, unlocking some of the biophilic health properties that have been shown to occur with exposure to nature in cities.

Continued on Page 259

Efficient units could be designed with less storage space thanks to fast on-demand delivery from neighbourhood storage facilities.

Efficient units: Warm, flexible living

A **Enclosed balcony.**
Enclosed balcony with floor-to-ceiling electrochromic glazing is usable throughout the year and provides generous daylight exposure.

B **Off-site storage.**
Residents would have access to off-site storage space at the neighbourhood logistics hub, with packages sent and delivered on demand by self-driving dollies and tracked via app.

C **Healthy, warm interiors.**
Mass timber buildings would offer warm, inviting spaces with exposed wood and elegant finishes. Exposed wood also unlocks "biophilic" health benefits, such as reduced stress, that have been shown to occur with exposure to nature in cities.

D **Space-saving flexible furniture.**
Clever design maximizes the space in these units, including features like convertible furniture, built-in shelving, and fold-out tables and beds to improve livability.

E **Efficient closets.**
Efficient closet designs make use of traditionally underutilized in-unit spaces.

F **Flexible wall systems.**
Flexible wall systems allow future connection to adjoining units. (See the next page for more details.)

Sidewalk Labs small research grant

Housing trends from around the globe

Commissioned research from Ryerson and OCAD points to innovations that can help cities tackle affordability.

Sidewalk Labs commissioned two reports on global housing innovations, one from the Ryerson City Building Institute and one from the System-CITY Research Team in the Faculty of Design at OCAD University.[55]

Here are a few ways other cities are trying to bring down the price of housing and keep a more economically diverse set of people living downtown:

Redesign the box.
Many cities have experimented with "micro-units": smaller homes and apartments of between 250 and 400 square feet. To make sure they are livable, the city can adopt minimum unit sizes and daylight requirements.

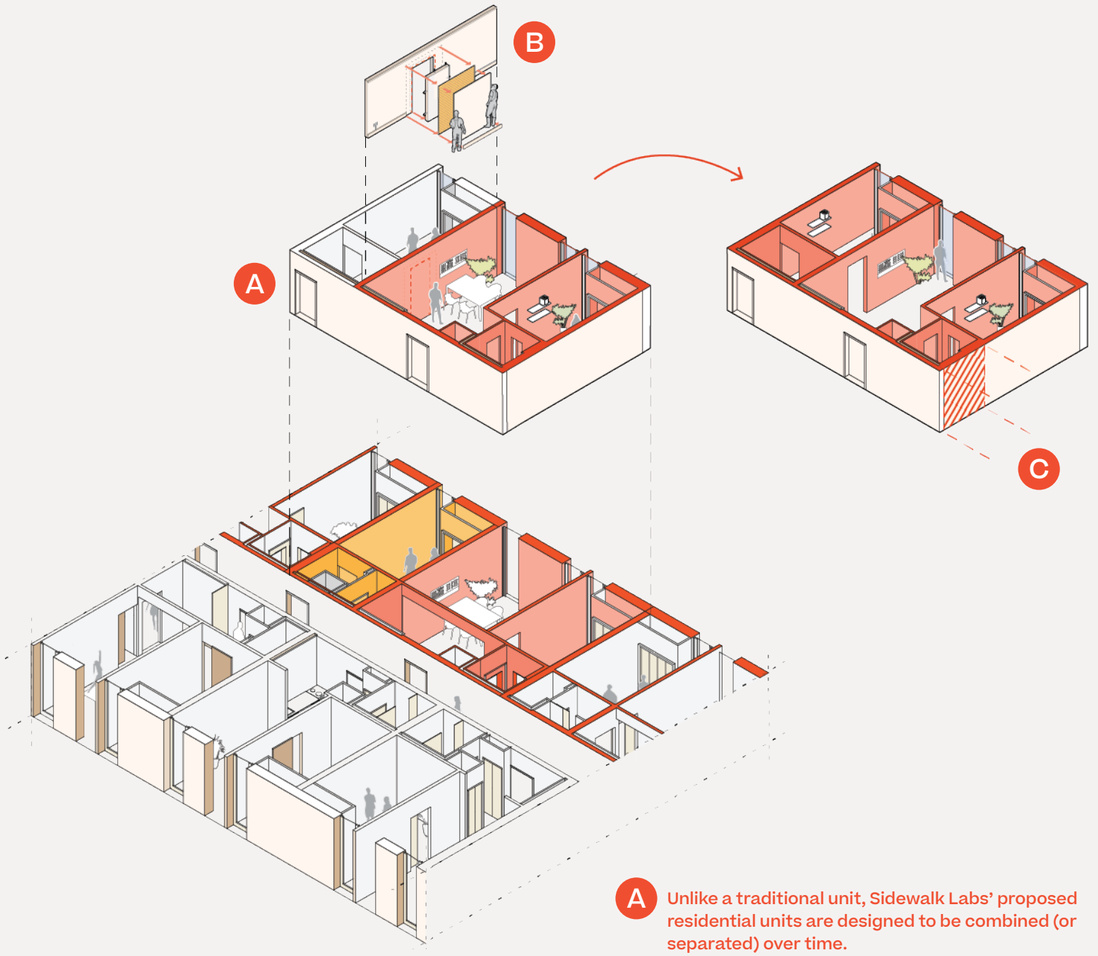
Unbundle the box.
Market condos often come with a long list of amenities: granite countertops, premium backsplash tile, washers and dryers, and more. These can all be unbundled from the cost of a home to make it more affordable.

Co-live a space.
Another strategy that combines well with smaller units is "co-living," where residents give up some private individual space in exchange for shared space within their building, such as children's spaces, workshops, and larger kitchens.

Build cheaper.
No matter the living arrangement, new construction practices can reduce the cost of development. These new approaches include modular construction, prefabrication, and adaptive designs that can meet the changing needs of residents and the community.

These are just some of the expanding options that can help increase the supply of housing while decreasing the cost.

Designing residential units to support changing household needs



A Unlike a traditional unit, Sidewalk Labs' proposed residential units are designed to be combined (or separated) over time.

B Flexible walls (shown in light red) and floor plans enable smaller units to be combined into larger ones.

C Consistent floor plans with aligned wet-box (kitchen and bathroom) corridors could be designed to accommodate the future addition or subtraction of adjacent units.

Continued from Page 255

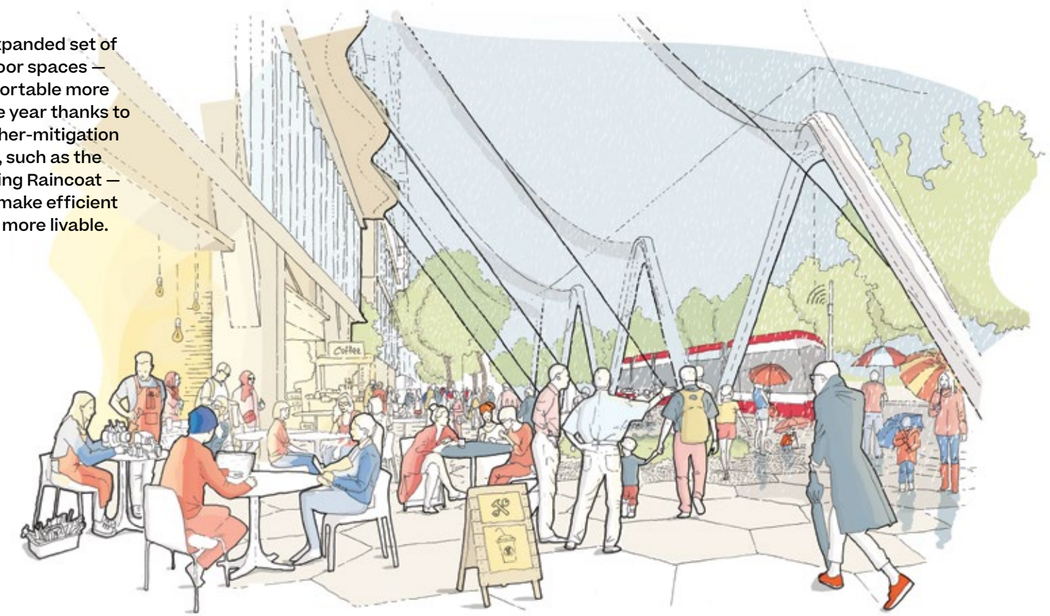
Flexible floor plans and wall panels. Floor plans with aligned wet-box (kitchen and bathroom) corridors could be intentionally designed to accommodate the future addition or subtraction of adjacent units. This approach, combined with built-in wall panel flexibility, would enable housing units to grow or shrink with household sizes, allowing families to "grow up" in Quayside. For example, a three-bedroom could be converted into two smaller units if a child leaves for college; conversely, smaller units could be combined into a larger one with the arrival of a new baby.

See the "IDEA District" chapter of Volume 3 for more details on regulatory aspects of the proposed district.

Expanded public realm. Sidewalk Labs' approach to public realm design is also meant to improve comfort for residents in efficient units. An expanded set of parks, plazas, and public spaces — comfortable year-round thanks to weather-mitigation systems — means people could spend more time outdoors, in spaces they can decide how to use themselves.

Together, these space-saving and neighbourhood-enhancing features would not only help meet the needs and preferences of modern-day Torontonian household, they would also make dense urban living more affordable to more types of people. Designed with similar features, ultra-efficient units would maximize space even further than the efficient units.

Sidewalk Labs proposes to seek relief from existing relevant guidelines and standards related to unit size to enable developers in the project area to create these new occupancy types within the IDEA District.



An expanded set of outdoor spaces — comfortable more of the year thanks to weather-mitigation tools, such as the building Raincoat — help make efficient units more livable.

Co-living offers shared amenities, such as a communal kitchen and dining room, to foster community among residents.

Providing co-living spaces to strengthen community

A co-living model combines efficient unit footprints with community-based programming and shared spaces designed to bring residents together.

Around the world, and with a few early examples in Toronto, co-living has gained popularity with younger professionals who enjoy the prospect of living in well-designed units, with access to common areas filled with more shared amenities than a typical apartment.[56] But co-living could also be built for seniors needing more in-building care, and for families with young children needing additional bedrooms or child-related amenities (such as shared playrooms) and services (such as daycare options).

Sidewalk Labs plans to dedicate certain floors of buildings in Quayside to co-living initiatives. A key feature of this housing option would be shared building space: communal areas could include co-working space, cooking and dining areas, exercise rooms, child recreational areas, and potentially a communal guest room that could be shared among residents.

These spaces would be designed to encourage social interaction among residents seeking a stronger community.

Creating value through "affordability by design"

Sidewalk Labs calls this approach towards efficient unit design "affordability by design," both because it provides more affordable options for households, and because it enables developers to meet affordable and below-market housing targets through the creation of additional units.

For example, in Quayside, the reduction in average size for each efficient and ultra-efficient unit would enable the creation of 87 more total units than would exist with conventional development.

As explained more in the following section on housing affordability, Sidewalk Labs estimates that this approach to affordability by design can create $37 million of value in Quayside and up to $475 million in value through 2048 at the full scale of the IDEA District — money that could be applied toward an ambitious 40 percent below-market program.

"Affordability by design" can create up to $475 million in value through 2048 to support an ambitious 40% below-market program across the IDEA District.

Ch–3

Part 3

Expanding Tools for Housing Affordability

Key Goals

1
Create an ambitious program to meet the housing affordability challenge

2
Achieve this program with innovation that yields greater affordability

Reducing construction timelines and risk, and making buildings more efficient and adaptable, are important steps towards creating neighbourhoods that are more affordable to more people. But to fully achieve a vision for inclusive communities, more direct action is needed — especially in a high-demand market like Toronto.

No issue is more pressing in Toronto right now than housing affordability.[57] Since 2006, home prices have far outpaced wage increases. Vacancy rates have reached all-time lows[58] and now sit around 1 percent — far below a minimum "healthy" rate of 3 percent[59] — making it more difficult for Torontonians to find affordable homes. Limited housing size options and an aging rental stock have further led to inadequate choices for multi-generational, single-person, and middle-income households.

The result is that Toronto's neighbourhoods are becoming increasingly stratified by income. In 1970, 58 percent of Toronto's census tracts (which are generally neighbourhood-sized) were considered middle-income. By 2015, only 29 percent of city tracts merited that designation. Toronto has tended to sort itself into "Three Cities": wealthy areas downtown, low-income areas forced to the edges, and middle-income pockets that continue to shrink.

The public sector has recognized these challenges and made important moves to address them. The recent National Housing Strategy laid out a $40 billion plan over 10 years to increase affordable housing, with significant provincial government matching requirements.[60] Toronto launched its Open Door plan in 2015 to provide new options and incentives for affordable housing, and recently announced the Housing Now Initiative that offers 11 city sites to create new housing units, including affordable rental.[61]

To build on that momentum and help Toronto face its housing challenges, Sidewalk Labs proposes a housing vision anchored by 40 percent of units at below-market rates. This vision is driven by the objectives of creating a truly mixed-income community with options across the income spectrum — not just narrowly affordable or market-rate — for people of all ages and families of all sizes. Sidewalk Labs proposes a two-part approach to achieve this vision that relies increasingly on private innovation and decreasingly on government sources.

First, Sidewalk Labs proposes to create new types of units designed with affordability in mind from the start. These efficient units could rent for less than comparable apartments downtown without sacrificing living quality thanks to space-saving designs, shared building amenities, and neighbourhood features that include on-demand offsite storage. Such units improve affordability by enabling developers to increase the supply of housing on a particular site, and they respond directly to the changing needs of families, seniors, and young professionals.

Second, Sidewalk Labs proposes to implement new tools that help the private sector support below-market rental housing over time. These tools include leveraging the value created by factory-based construction to help developers meet ambitious affordable housing targets while still earning returns, and implementing a resale fee on market-rate condos to help pay for below-market units and make downtown living affordable for more people. A proposed housing trust fund could "lock-box" these savings to create a sustainable source for below-market units.

In Quayside, these approaches could support a paradigm-shifting housing program featuring 40 percent of units at below-market rates, with half of the entire program consisting of purpose-built rentals. The neighbourhood can also begin to implement and refine the factory-based construction approach and demonstrate its value to developers in terms of time and cost.

But while additional tools such as factory construction and resale fees can be initiated in Quayside, a neighbourhood of this scale and near-term development timeline requires significant support from existing government funding sources to meet — and exceed — the affordability objectives established by Waterfront Toronto.

To support a mixed-income community, Sidewalk Labs proposes a housing vision with 40% of units at below-market rates.

The Sidewalk Toronto project can set a new precedent for housing affordability, generating funding through off-site construction, efficient unit design, and other innovative tools.

This plan creates nearly

1.4 billion

for below-market housing.

Implemented at the full scale of the IDEA District, this approach can unlock powerful tools that enable the private sector to support the public sector in delivering below-market housing. Sidewalk Labs estimates that the potential value created by factory-based construction, condo resale fees, and efficient unit designs could amount to over $1.4 billion through 2048.

Such a program could include around 6,800 affordable housing units, representing nearly a third of the current annual citywide target for new affordable rental housing units, in accordance with the city's Open Door program.

In so doing, the Sidewalk Toronto project would help set a new precedent for housing affordability, demonstrate that it is possible for cities to hit ambitious affordability targets while relying on a more balanced mix of government funding sources and support from private sources, and above all, give rise to mixed-income communities that live up to the city's values for inclusive growth.

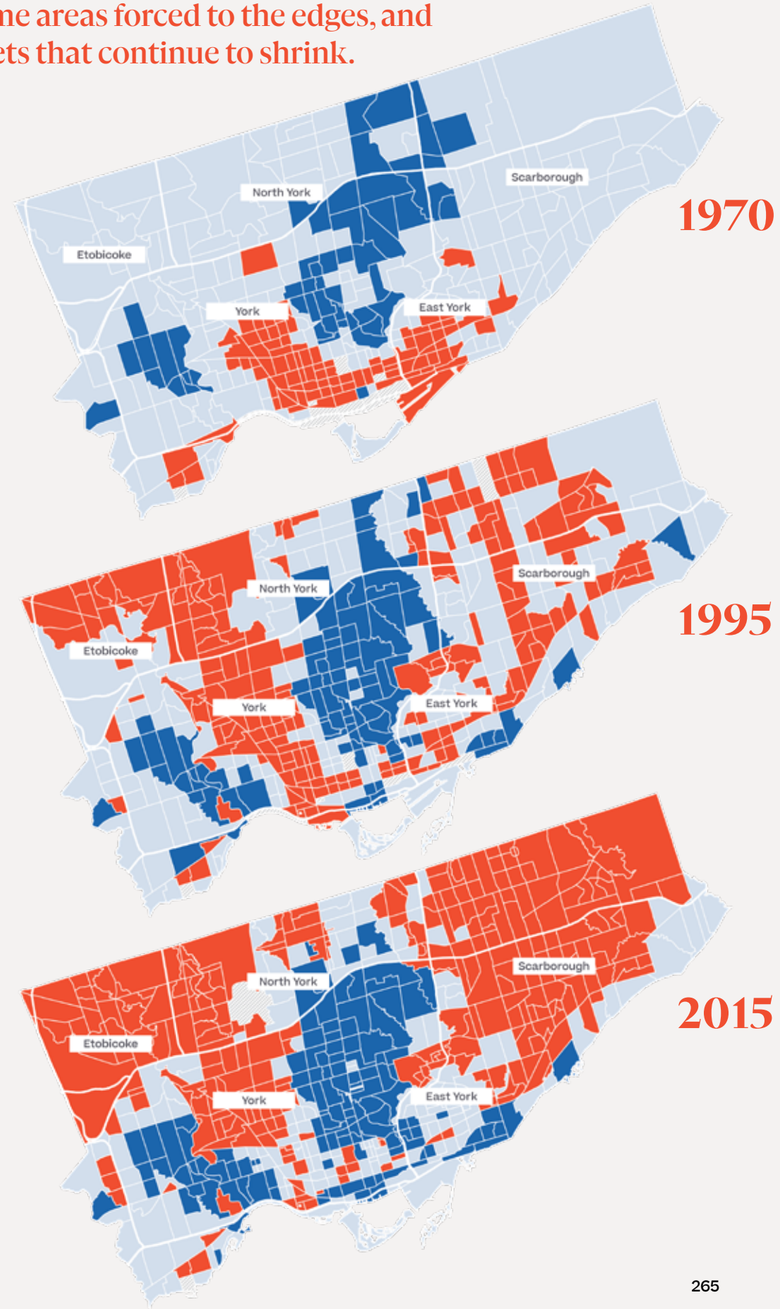
Toronto's fading middle-income neighbourhoods

Since 1970, Toronto's neighbourhoods have become increasingly segregated by income, with wealthy areas downtown, low-income areas forced to the edges, and middle-income pockets that continue to shrink.

High-income

Middle-income

Low-income



Note on methodology: Average individual income by census tract, or neighbourhood, compared to the Toronto Census Metropolitan Area (CMA) average, which was $5,756 in 1970, $28,980 in 1995, and $50,479 in 2015. Middle-income neighbourhoods refer to average individual incomes that are 20 percent above or below the CMA average, or at 80-120 percent of CMA. High-income refers to 120 percent and above; low-income refers to less than 80 percent.

Source: Statistics Canada Census Profile Series 1971, 1996, 2016; analysis by J. David Hulchanski, Neighbourhood Change Research Partnership.

Three factors that informed Sidewalk Labs' approach: Rental supply, funding, and demographic shifts

Three clear factors are driving Toronto's affordability challenges: a housing ecosystem that incentivizes condo development over purpose-built rentals; affordable housing policy that has faced historical defunding; and shifting demographics defined by record growth and more young people, seniors, and multi-generational households.

1

A development landscape lacking rentals.
Condo development has dominated Toronto residential construction for the past two decades. At the same time, Toronto has seen a precipitous decline in purpose-built rental housing.

As shown in the bar chart on the opposite page, Toronto once constructed a lot of purpose-built rentals: roughly 12,000 units a year from 1960-1974, and 3,000 a year in the decade that followed. That rental boom occurred thanks to strong tax incentives and government funding.[62] But as such incentives disappeared in the 1980s, so, too, did new rental construction.

As a result, the city has missed out on decades of "filtering," the process by which new purpose-built rentals age and thus become more affordable over time.[63] According to research by Ryerson University and Evergreen, Toronto will only rebalance its market and improve long-term affordability if purpose-built rentals make up a sizable share of new housing supply — approximately 8,000 units a year through 2041.[64]

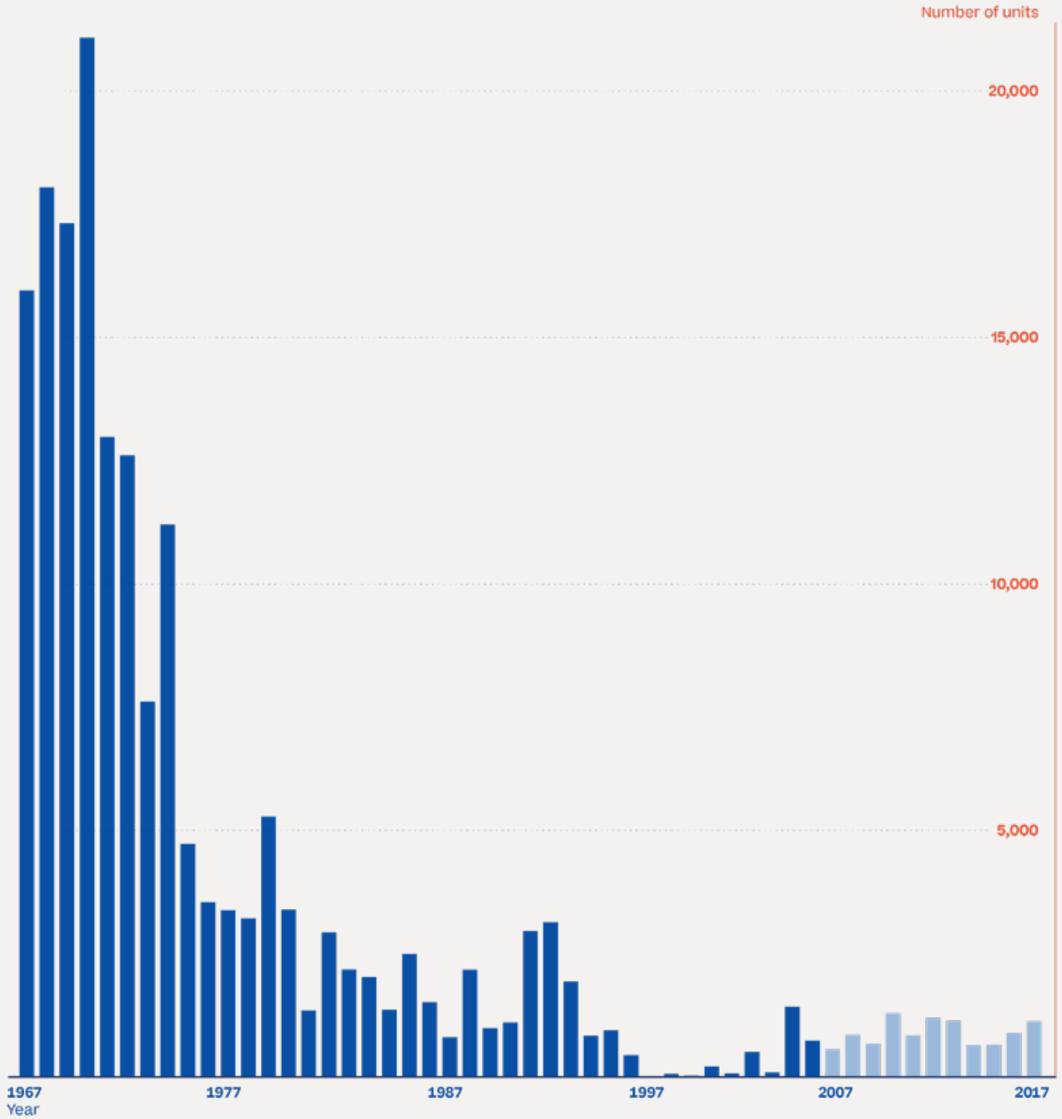
This imbalance impacts renter households in personal ways. Households unable to find a purpose-built rental unit often find accomodations on the secondary market, renting out condo (or other accessory dwelling) units instead. Condo renting is a less secure form of tenure than professionally managed rentals, since a condo can quickly transfer ownership or be taken off the market if an owner decides to sell or move back in.

It also hampers government's ability to harness the private sector for affordable housing — since tax incentives and other programs often rely on rental stock to do so. In the past year, Toronto has seen an increase in rental housing production,[65] particularly luxury rentals, in part due to new government programs, such as the Canada Mortgage and Housing Corporation's (CMHC) rental construction financing initiative program. But despite this recent rise, market conditions still favour the pre-sale of higher-end condos to reduce the risks of financing new development.

How this trend informed the approach:
Sidewalk Labs recognized that purpose-built rentals must form the core of any proposed housing program, both to build on the recent progress being made in this area and to improve long-term affordability within the IDEA District.

The decline of Toronto's purpose-built rental stock

Toronto has seen a precipitous decline of purpose-built rental development since the 1960s.



Source: CMHC

2

Limited affordable housing funding.
Toronto has a proud history of providing affordable housing. The mid-1970s were a bright spot of affordable housing,[66] as public subsidies from all levels of government flowed to private developers, nonprofits, and co-ops alike, leading to neighbourhoods like St. Lawrence that offered a robust social and cultural mix of owners and renters, families of different sizes, residents from different backgrounds, and people of all incomes. This public investment began to fade in the mid-1990s.

As mentioned on Page 262, today all three levels of Canadian government are increasing their support for affordable housing through a variety of plans and programs. As a result, the city has seen progress, such as the Regent Park revitalization, which is on track to redevelop almost 1,800 affordable units with rent geared to income, as part of a landmark five-phase public-private partnership.[67]

Still, there is an opportunity to better engage private sector partners on affordable housing. Increasing predictability and certainty of funding can enable developers to contribute more affordable housing.

How this trend informed the approach:
Based on these trends, Sidewalk Labs recognized that the private sector must play an important role in identifying financial tools that can build on public funding and help extend options across the income spectrum, including to middle-income households that currently cannot pay market rates but do not qualify for affordable housing.

3

Shifting demographics.
Since 2001, Toronto has seen record growth of intergenerational households,[68] and for the first time ever, single-person households in Canada have overtaken all other types as the dominant type.[69] Coupled with rising rates of seniors, particularly in the neighbourhoods surrounding Quayside, these shifting demographics highlight where housing options fall short.

Hampered by a limited number of multi-bedroom units downtown, Toronto families sometimes become "condo hackers" — packing far more people into a one-bedroom condo than is desirable. Older residents also struggle to find a suitable place downtown to age in place. Some are empty nesters who have more bedrooms than they need. Others simply need more support and community.

Then there are the students and young people aggressively competing for the few attainable rentals on the Toronto market. Too often the result is that young people who want to live close to the action instead wind up living back at home with their parents — a situation that affects 47 percent of Toronto residents aged 20 to 34[70] — or squeezing into shares not designed for multiple tenants.

How this trend informed the approach:
These trends informed Sidewalk Labs' approach to designing efficient and co-living units that respond to changing needs, including a mix of sizes, tenures, and flexible units that can accommodate households at every life stage. This approach to "affordability by design" can also help deliver below-market housing by increasing the supply of units a developer can provide across a project.

Goal 1

Expanding Tools
for Housing Affordability

Create an ambitious program to meet the housing affordability challenge: 40% below market

These factors and trends formed the basis for Sidewalk Labs' proposal for an ambitious housing program whose cornerstone is a proposed 40 percent of units at a below-market rate. This vision builds on the affordability commitments set by Waterfront Toronto but pushes beyond them to demonstrate the private sector's ability to support the shared objective of truly mixed-income communities that are inclusive of all households, responsive to resident needs, and adaptable over time.

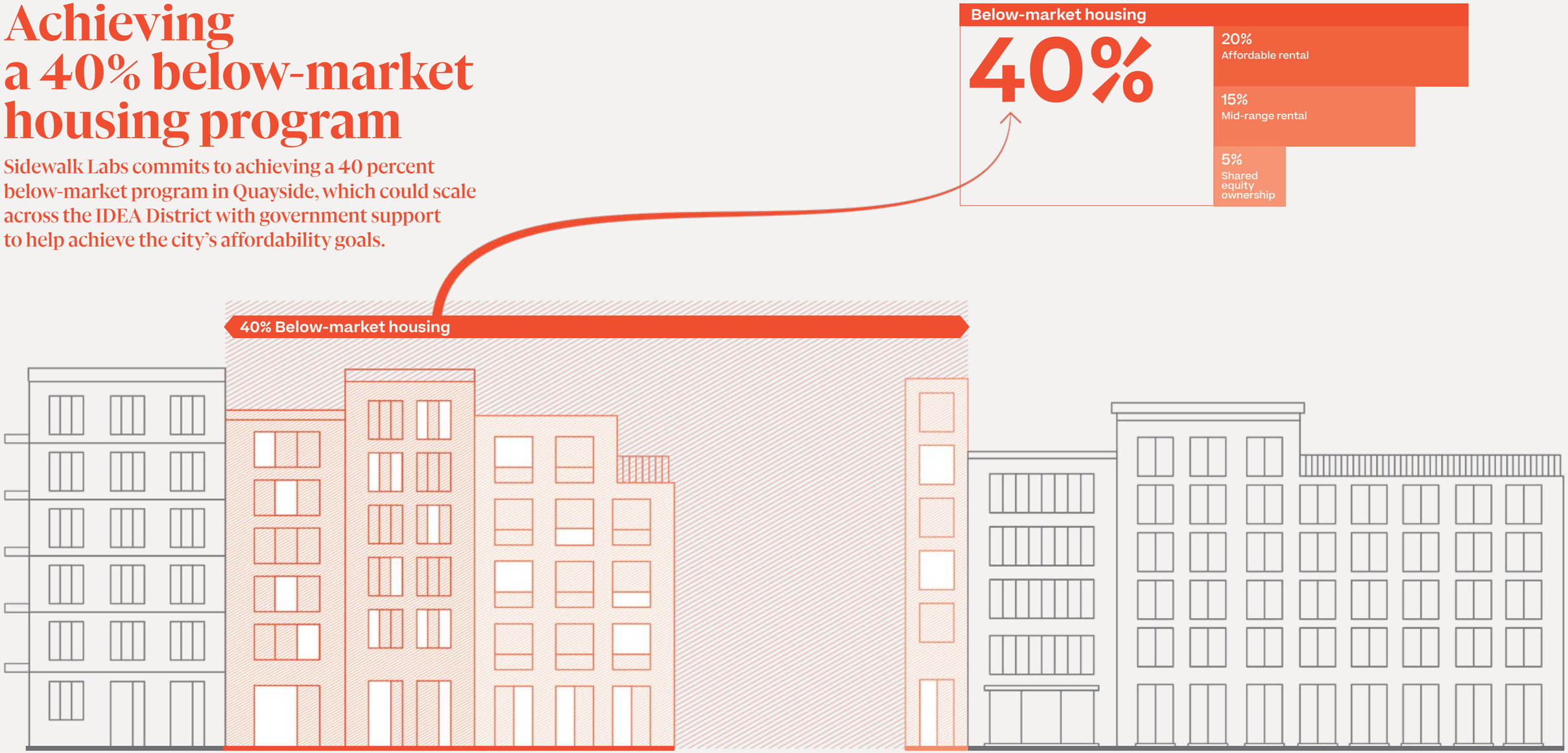
Sidewalk Labs aims to expand affordability, dedicating 20% of units to middle-income households.

The below-market housing would include 20 percent traditionally "affordable" housing units, a quarter of which would go towards households with "deep" affordability needs. It would also include 20 percent middle-income units (a quarter of which would be "shared equity" units that create an affordable ownership option), expanding the definition of affordability from its current standards. And to improve long-term affordability, half of the total proposed residential program would consist of much-needed purpose-built rentals.

Sidewalk Labs commits to achieving this program mix in Quayside using a combination of existing government funding sources and new innovations. It hopes to prove that such a program composition could be financially feasible across a larger area, once the innovations initiated in Quayside reach their full potential.

Achieving a 40% below-market housing program

Sidewalk Labs commits to achieving a 40 percent below-market program in Quayside, which could scale across the IDEA District with government support to help achieve the city's affordability goals.



Market-rate rental
These units would be purpose-built rentals renting at market rates.

Affordable rental
These units quality as affordable housing in Toronto (below 100 percent Average Market Rent) and include at least 5 percent deeply affordable units (at 60 percent AMR or below).

Mid-range rental
These units are geared towards middle-income families who do not today qualify for affordable housing (100-150 percent AMR).

Shared equity ownership
These units would offer a new type of affordable homeownership for middle-income families unable to afford full ownership.

Market-rate ownership
These condo ownership units would, as with all other unit types, offer a range of new options, including family units and co-living spaces.

Affordable rental housing (20 percent).
A key element of Sidewalk Labs' proposed housing program is providing affordable rental housing for lower- and moderate-income households in Toronto.
To ensure a diverse, mixed-income community, the program would accommodate households at a range of incomes below the City of Toronto's definition of affordable housing (households paying less than 100 percent average market rent eligible to receive government funding) — not just the upper end.
At least a quarter of this supply will go towards households with "deep" affordability needs (below at least 60 percent AMR). In Quayside, Sidewalk Labs proposes keeping units affordable for the long term.

Additionally, in Quayside, Sidewalk Labs proposes to deliver the lower-income affordable units in close collaboration with non-profit operators. Rather than wait until after the development is approved, Sidewalk Labs would invite non-profit organizations to participate in the earliest stages of the design process (see sidebar on Page 273). By tapping into the deep expertise of non-profit housing operators, Sidewalk Labs seeks to ensure that the affordable housing truly meets the needs of all its residents— including those with lower incomes — while setting a path for continued capacity-building in the sector.

Mid-range rental housing (15 percent).
A strong housing plan must provide for middle-income households that do not qualify for traditional affordable housing yet struggle to pay market rates. A core feature of the proposed housing program is that 15 percent of all housing units would be purpose-built rentals priced specifically for middle-income households in the mid-range (100 to 150 percent) AMR band.

In Quayside, to ensure these units remain affordable for middle-income families, Sidewalk Labs plans to implement a rent cap. For example, rents for a two-bedroom unit would range from $1,492 to $2,238, according to existing rental bands established by the city.

Qualifying for a below-market 2BR rental in Quayside

In addition to providing traditional affordable housing, the Sidewalk Labs plan provides below-market housing for middle-income households.

	Mid-range	Affordable	Deep affordable
Households earnings at this level or below: *	$107,424	$71,616	$42,970
... can expect to pay this monthly rent: **	$2,238	$1,492	$895
... which corresponds to this level of average market rent (AMR) as defined by the city: ***	150%	100%	60%

* As determined by the City of Toronto's initial income limit, calculated as four times the monthly occupancy cost for the housing unit, multiplied by 12. CMHC and other programs may use different definitions. Numbers rounded.

** Monthly rent figures that correspond to AMR are released each year by CMHC and are used to set income thresholds for developers leasing up affordable rental units. Those shown correspond to 2019 AMR figures released by the City of Toronto and are not yet adjusted for utility allowances.

*** The City of Toronto defines affordable rental housing as being at or below 100 percent AMR. Sidewalk Labs defines "below-market" to include mid-range rental housing at 100-150 percent AMR as well.

Source: City of Toronto, 2019

In Focus

Community engagement

Catalyzing non-profit housing collaboration

Sidewalk Labs plans to collaborate with non-profit operators to deliver lower-income affordable units in Quayside, and has engaged non-profit leaders to identify ways to strengthen partnerships.

During its public engagement process for the Sidewalk Toronto project, Sidewalk Labs partnered with United Way Greater Toronto to convene a roundtable discussion with non-profit leaders representing a dozen local housing organizations. The group identified ideas and guiding principles for what partnership with non-profits in Quayside could look like. These ideas included allowing non-profits to:

Express interest.
Non-profits will be invited to submit letters of interest for participation in the project, enabling them to engage early in the development process without undue burden. Non-profits could become involved without having to spend resources on the production of an uncertain Request for Proposals response.

Be rewarded for collaboration.
An operating partner (either one or more non-profits) would be selected through a transparent evaluation process designed specifically to reward joint applications that serve diverse deep affordability populations.

Participate in design.
Selected non-profits would be invited to participate actively in the design process, helping the project identify and meet the housing needs of specific populations and create a physical design that is optimized for operations.

Sidewalk Labs believes that active collaboration would make the waterfront's proposed mixed-income neighbourhoods stronger overall. Over time, this engagement could help non-profits build their capabilities for creating and delivering affordable housing. It would also demonstrate ways of working between the non-profit and private sectors.

Market-rate rental housing (15 percent). As part of a balanced offering, the proposed unit mix would include 15 percent of units as professionally managed, market-rate rentals, contributing much-needed supply to the Toronto market. This need is driven in part by unserved segments of the population, such as empty nesters seeking to downsize into downtown living.

Shared equity housing (5 percent). In addition to mid-range rentals, 5 percent of proposed units would involve a shared equity program that enables middle-income households to own part of an apartment, providing a path to build equity while renting. This shared equity program would help address a common barrier to home ownership for middle-income Torontonians: the need for a significant down payment.

Traditional home buyers own 100 percent of a property, often with help from a bank or other lender, with a considerable down payment. A shared ownership program enables home buyers to put a lower down payment towards a partial equity stake of a property, in partnership with a non-profit or other independent entity. Residents in shared ownership programs pay mortgage payments on the part they own and pay rent on the part they do not. Buyers also profit from the appreciation of their unit, with the ability to cash out when they move.

In Quayside, Sidewalk Labs proposes to deliver this option at cost to a capable partner, believing it would contribute meaningfully to middle-income housing options. (The cost of providing this option represents a contribution by Sidewalk Labs of $13.5 million, since delivering shared equity units comes at an opportunity cost of delivering condo units.) Based on preliminary discussions with local providers of affordable ownership units, there appears to be an appetite in Toronto to partner and explore this model further.

Although the city's Home Ownership Assistance Program has made meaningful strides towards the goal of reducing barriers to home ownership, Sidewalk Labs' shared equity program would seek to address a significant drawback of such programs, which is that they typically select a single "winning" household that takes all of the value of the property upon the first sale. In Quayside's proposed shared equity model, the unit would remain affordable for the long term.

Market-rate condo housing (45 percent). Because creating a mixed-income community means including market-rate as well as below-market households, Sidewalk Labs' proposed program would include about 45 percent market-rate condos. These condos would bring in revenue, which in Quayside would cross-subsidize the overall program. And, as explored further on Page 283, a condo resale fee would generate private funds for affordable housing when condos are resold.

In Focus

Innovation explainer

Two examples of how shared equity units could work in Quayside

The program aims to address a common barrier to home ownership for middle-income households: the need for a significant down payment.

	One-bedroom $375,000		Three-bedroom $600,000	
	Traditional ownership	Shared equity program	Traditional ownership	Shared equity program
Down payment	**$75,000** 20% on 100% ownership stake	**$15,000** 20% on 20% ownership stake	**$120,000** 20% on 100% ownership stake	**$24,000** 20% on 20% ownership stake
Monthly payment	**$1,600** mortgage	**$1,300** $300 mortgage and $1,000 rent	**$2,500** mortgage	**$2,100** $500 mortgage and $1,600 rent

Young couple

As an example of how the program works, consider a couple moving into a one-bedroom apartment that costs $375,000. In a traditional ownership scenario, the buyer might have to pay up to $75,000 up front for a 20 percent down payment, with a monthly mortgage of roughly $1,600. In the shared equity program, the couple could put down just $15,000 for a 20 percent down payment on a 20 percent ownership stake, for a total monthly cost of just over $1,300, comprising $300 in mortgage payments on the part they own and $1,000 in rent for the rest. If they decided to sell in Year 5, the couple could stand to make around $12,000 profit assuming 3 percent annual appreciation on their unit.

Young family

Similarly, consider a young family that is tired of "condo hacking" a one-bedroom rental and finds a three-bedroom condo at $600,000, hoping to obtain more room for their children. In a traditional scenario, the family's down payment might be as high as $120,000, with a monthly mortgage of roughly $2,500. In the shared equity program, the family could put down just $24,000 for a 20 percent down payment on a 20 percent ownership stake, paying rent on the rest for a total of $2,100 a month, comprising $500 in mortgage payments and $1,600 monthly rent. If they decide to sell in Year 5, the family stands to make up to $20,000, assuming 3 percent annual appreciation on their unit.

Note: Figures on this page are provided for illustrative purposes only.

How Sidewalk Labs plans to work with a non-profit partner to deliver shared equity units

Sidewalk Labs' sale of units at cost to a non-profit would enable the non-profit to provide equity stakes at below-market prices to qualifying middle-income households. The non-profit would receive steady rental payments on the portion of the home that is not owned, plus any home price appreciation on its owned portion upon resale. In addition, the non-profit would oversee restrictions on resale to ensure ongoing affordability to subsequent income-qualifying households, which could include an independent appraisal process to determine selling price and maintenance of an applicant waitlist. In the young family example above, the entity would purchase at cost from Sidewalk Labs, sell 20 percent at the same price to the family, and hold the remaining 80 percent at a cost basis of $480,000 (80 percent of the $600,000). It would then receive a 4 percent rental yield, or $103,500 over five years, plus house price appreciation of $76,500 (on their 80 percent share), leading to a 7 percent annual return, or profit of $180,000 if the unit sells.

The Sidewalk Toronto project can demonstrate ways for cities to hit ambitious affordability targets with a more balanced mix of government and developer funding sources.

Innovation case study

Reimagining the process of applying for housing

A digital tool could create a one-stop portal for housing applications and updates.

Working with the City of Toronto, Sidewalk Labs proposes to develop a streamlined, digital application process for all housing options in Quayside, including mid-range, market, and affordable units. This would address known challenges in today's affordable housing application process and also foster an unparalleled resident experience of diversity and inclusion for all income levels.

Today

Many different options, no single source.
Affordable housing applicants can find out about a unit through a housing provider's flyer, by calling the city or one of its affordable housing partners, or even through social media — a highly decentralized process compared to the city's centralized waitlist for social housing units.

Many separate applications.
It is hard to keep track of each developer application's unique eligibility or submission requirements.

Hard to determine status.
Residents who complete an application might not receive updates for a long time or might be left in the dark about where they are in the process.

Future

One-stop shop.
Affordable housing applicants could find all housing opportunities in a one-stop shop. Developers could upload and market projects easily into a portal.

Common application.
A digital application means people could apply to as many projects as they would like, with a single form. Developers would have more confidence in the income-eligibility process, through an auto-verification functionality that could ensure applicants pass income eligibility requirements.

Real-time updates.
Applicants could get updates in real time and understand timing and eligibility expectations for housing matches. Developers could expedite lease-up timelines, thus reducing vacancy risk and other lease-up challenges.

Expanding Tools
for Housing Affordability

Achieve this program with innovation that yields greater affordability

Informed by Toronto's existing affordability challenges, Sidewalk Labs' vision for housing includes 40 percent of units at below-market rates, a focus on purpose-built rentals to improve long-term affordability, and new options for seniors, young professionals, families, and middle-income households. But identifying an ambitious program is not enough — there must be a credible financial plan to achieve it.

To make the economics work, developers of affordable housing have typically relied on a mixture of public sources of funding and high-end, market-rate rentals to subsidize below-market units. While this approach can deliver some measure of affordability, it also creates a barbell effect, with new developments consisting primarily of luxury units and a handful of affordable apartments. To break this mold and create a broad diversity of incomes across a given housing development, Sidewalk Labs has explored a range of traditional and innovative funding sources.

Sidewalk Labs has estimated the cost of implementing this housing vision by comparing the costs of delivering a program with 40 percent of units at below-market rate to the land value that would exist in a conventional market-driven development program, which would deliver the bare minimum of affordability required.

In Quayside, achieving a housing program of roughly 2,600 total units with roughly 1,040 below-market units would cost an estimated $229 million. At the full scale of the IDEA District, achieving a total cumulative residential program of more than 34,000 units that include more than 13,600 below-market units would cost an estimated $3.9 billion.

To help cover the costs of this greater level of affordability, Sidewalk Labs identified categories of traditional public sources, including existing government programs, land value, and other potential contributions. Sidewalk Labs also identified three new private sources that together enable the traditional public sources to go farther.

These private sources begin with more efficient unit design, which creates value by increasing the supply of housing units a developer can provide across a given project — an approach that Sidewalk Labs calls "affordability by design." A second source is new land value unlocked by factory-based construction techniques, as achieved by a factory in Ontario specializing in modular building components made from mass timber. A third source could be revenue generated by condo resale fees.

Continued on Page 280

Identifying funding sources to achieve a 40% below-market program

With these sources, Sidewalk Labs proposes to achieve a 40 percent below-market program in Quayside and to demonstrate the potential impact of innovative financial and design tools to achieve this same program at the full scale of the IDEA District.

	Quayside		IDEA District	
	Below-market program achieved*	$M	Below-market program achieved	$M
Traditional public sources	**20%**	**$115**	**25%**	**$2,492**
Existing government programs**	13	77	10	997
Land value or other gov't contributions	7	38	15	1,495
New private sources	**7%**	**$37**	**15%**	**$1,435**
Affordability by design	7	37	5	475
Factory-driven land value	0	0	7	639
Condo resale fee***	0	0	3	321
Sidewalk Labs contribution	**13%**	**$77**	**-**	**-**
Total sources	**40%**	**$229**	**40%**	**$3,927**

* These figures reflect the incremental impact of each source towards creating a below-market program, based on overall 40 percent below-market program cost of $229 million.

** Existing government program figures are estimated for Quayside based on recent awards and the proposed below-market housing program. These figures assume programs are scaled up across the IDEA District on the same basis as in Quayside. As a result, totals may exceed annual budget allocations pending timeline of affordable units coming online between 2024 and 2048.

*** Analysis assumes 2.5 percent annual inflation rate.

Continued from Page 278

In Quayside, traditional public sources could provide the funding needed to deliver 20 percent affordable housing, consistent with current requirements. The remainder of the below-market program proposal could be covered, in part, by affordability by design (7 percent). But factory-based construction and condo resale fees require a longer timeline to realize value (through factory efficiency and sales, respectively), leading to a need for additional private sources in Quayside.

To realize the full below-market program vision in Quayside, Sidewalk Labs proposes to make a contribution of $77 million, in an effort to catalyze those sources for the future while still realizing an ambitious affordability program in the present. (This contribution would exist in addition to other innovation investments, including support for the Ontario-based factory for mass timber building parts described earlier in this chapter, on Page 210.)

At the full scale of the proposed IDEA District, however, private sources can realize significant value. In total, it is possible to achieve a 15 percent below-market program using private sources, which could generate more than $1.4 billion between 2024 and 2048. To achieve a 40 percent target at the scale of the IDEA District, the remainder would have to be supplied by existing government programs, contributing land at below-market value, or other sources.

Together, this combination of traditional public sources and innovative private sources could help deliver a groundbreaking housing program that would supplement reliance on existing government programs to enable unprecedented levels of affordability.

New private sources could unlock

$1.4 billion

for below-market housing.

The following sections describe the proposed funding sources in greater detail, including their potential application in Quayside by Sidewalk Labs, and across the IDEA District by other developers.

New private sources

To achieve its 40 percent below-market housing vision, with a diverse range of incomes across the community, Sidewalk Labs proposes the creation or use of several private sources of funding.

These sources begin with the value created by more efficient unit design — an approach that Sidewalk Labs calls "affordability by design." They also include new land value unlocked by accelerated construction techniques, catalyzed by a factory in Ontario specializing in modular building components made from mass timber. A third source could include revenue generated by condo resale fees.

Additionally, a proposed affordable housing trust could package some of these new funding sources to meet affordability objectives.

While these tools would be initiated in Quayside, they require varying timelines and development scales to provide sufficient funding sources for the housing vision. But once the viability of these tools is demonstrated, Sidewalk Labs estimates they could generate over $1.4 billion to support housing affordability — enabling developers to meet ambitious below-market housing targets while still achieving reasonable returns.

Affordability by design.

To help achieve its 40 percent below-market housing vision, Sidewalk Labs plans to create value by designing affordability into its proposed housing units.

As described on Page 253, Sidewalk Labs plans to provide efficient, ultra-efficient, and co-living units in Quayside that are designed to make the most of their space through features such as multi-purpose furniture; reduced in-unit storage, enabled by on-demand storage recovery in the neighbourhood; and shared building amenities, such as communal eating or co-working areas. While these units are smaller than comparable units on the market, they also enable affordability and their efficient designs provide for high-quality living.

(In addition to efficient and ultra-efficient units, Sidewalk Labs also proposes to create a minor amount of new "standard" units that are comparable in size to existing downtown developments.)

The ability to design efficient units that remain comfortable enables developers to create more total units across a given project. This additional supply increases the revenue potential for developers without increasing the cost basis, creating new value that can be applied towards a mixed-income housing program.

For example, in Quayside, Sidewalk Labs' proposed efficient unit — averaged across different unit types and based on a unit mix that skews towards more bedrooms — would be 7 percent smaller than its equivalent proposed standard unit. Efficient units would benefit from features such as multi-purpose furniture that enable a smaller footprint.

Creating value for below-market housing through efficient unit design

With efficient unit design, Sidewalk Labs is able to build an additional 87 units of below-market housing at Quayside when compared to traditional unit designs. This has the potential to generate an estimated $37 million in additional revenue, which can help support the below-market housing program.

Assuming 535,035 square feet dedicated to below-market rental units	**Average below-market size** (sq ft per unit)	**Number of units**	**Value** (in millions)
Standard unit design	638*	839	$207
Efficient unit design	578**	926	$242
Impact of efficient unit design	60 fewer square feet per unit on average	87 more total units	$34 for below-market housing***

* Standard unit design is based on a market landscape analysis of comparable downtown developments.

** The average efficient unit size indicated on this table is slightly larger than the overall average efficient unit size (see prior table) because it is weighted by bedroom splits for an exclusively below-market housing program. Sidewalk Labs' proposed housing program is grounded in demographic need, which allocates more family-sized units (with more bedrooms) to below-market units.

*** Note that $37 million in sources from affordability by design includes $3 million attributable to market rental housing not included in this analysis.

Assuming the same amount of area is dedicated to below-market housing, this reduction in average size enables the creation of 87 more units in Quayside than would otherwise exist in a conventional development.

In Quayside, Sidewalk Labs estimates that affordability by design could create $37 million in value that could be applied towards its housing vision. Applied at the full scale of the IDEA District, affordability by design could generate $475 million in value that could contribute to ambitious below-market housing targets.

Critically, affordability by design not only enables more below-market housing but also provides a set of new downtown living options that respond to the needs of families, seniors, young professionals, and other groups.

Unlocking land value from factory-based construction.
As described on Page 208, Sidewalk Labs proposes to build residential and commercial spaces using an off-site factory process that can accelerate project timelines and enhance cost certainty. Once proven, these outcomes would enable developers to pay more for land, with such premiums directed towards below-market housing.

Sidewalk Labs estimates that it will take at least 6 million square feet of buildable area for the factory to hit peak efficiency; so, the impact of this approach would not take effect in Quayside.

This estimate takes into account the fact that, during the ramp-up period with the first assemblies, the factory processes would take time to reach operational efficiency and a payback on the initial investment, as well as to stabilize an operating margin that reduces timelines and risk for developers. This estimate is based on the capital cost required for the factory and initial operating costs.

But when the expected efficiencies from this investment are realized at scale, factory construction would increase land values in two key ways: faster construction and reduced project risks.

↳ Faster construction. Sidewalk Labs has estimated that its factory process can reduce project timelines by 35 percent, thanks largely to dramatic reductions in onsite assembly time. That accelerated speed would enable developers in the Sidewalk Toronto project area (whether Sidewalk Labs or any other third party) to bring projects to market more quickly, recover their investment faster, reduce their exposure to rising interest rates, and potentially complete more projects over the same amount of time. For commercial properties, this speed also opens up the possibility of pre-leasing to a new category of tenants unserved by the current market: rapidly growing startups that are unable to pre-lease four to six years before delivery, given unknown future business needs.

↳ Reduced risk. The factory-based construction process also creates a more reliable set of costs related to design and materials procurement, primarily by providing developers with a library of pre-designed (yet customizable) building parts that have been pre-approved for use. Additionally, this library of parts has been optimized for shipping, reducing transportation costs, and created for faster assembly, as described on Page 227. The greater reliability of this factory supply chain reduces the need for developers to build "contingency" costs into their projects and should command tighter risk premiums from equity.

Together, these factors could enable more affordability in multiple ways. First, developers who recognize these benefits could be willing to pay more for land, the value of which could be applied to below-market housing. That is the approach used to generate the estimates shown in the funding sources table.

An alternative would be that government could increase affordability requirements, knowing that better project economics would enable developers to meet them while still clearing returns.

Sidewalk Labs estimates that the premium that would accrue to land when developers have access to factory-based construction techniques has the potential to generate proceeds estimated at $639 million across government-owned parcels across the IDEA District over the 24 years, from 2024 to 2048.

A condo resale fee could generate
$321 million
by 2048.

Generating new funding with a condo resale fee.
Sidewalk Labs proposes implementing a 1 percent fee on the resale of all condo units in the Sidewalk Toronto project area as a new source of private funding for affordable housing.

As described on Page 266, one of the barriers to creating affordable rental housing in Toronto today is the need to offset affordable units with high-priced condos to make projects hit target returns. With a resale fee such as the one Sidewalk Labs proposes to implement in Quayside and across the project zone, condos could help support rental economics, creating a self-sustaining ecosystem for mixed-income housing.

The resale fee could be built in from the start as a land encumbrance — such as with a restrictive covenant or other legal mechanism; it would not be a new government-levied tax — to support affordable housing development. Sidewalk Labs would take a catalyst role by applying the condo resale fee to its condo units in Quayside, aiming to demonstrate that the fee would not impact condo sales or pricing, and thus that such a model is feasible and viable for future developers within the IDEA District.

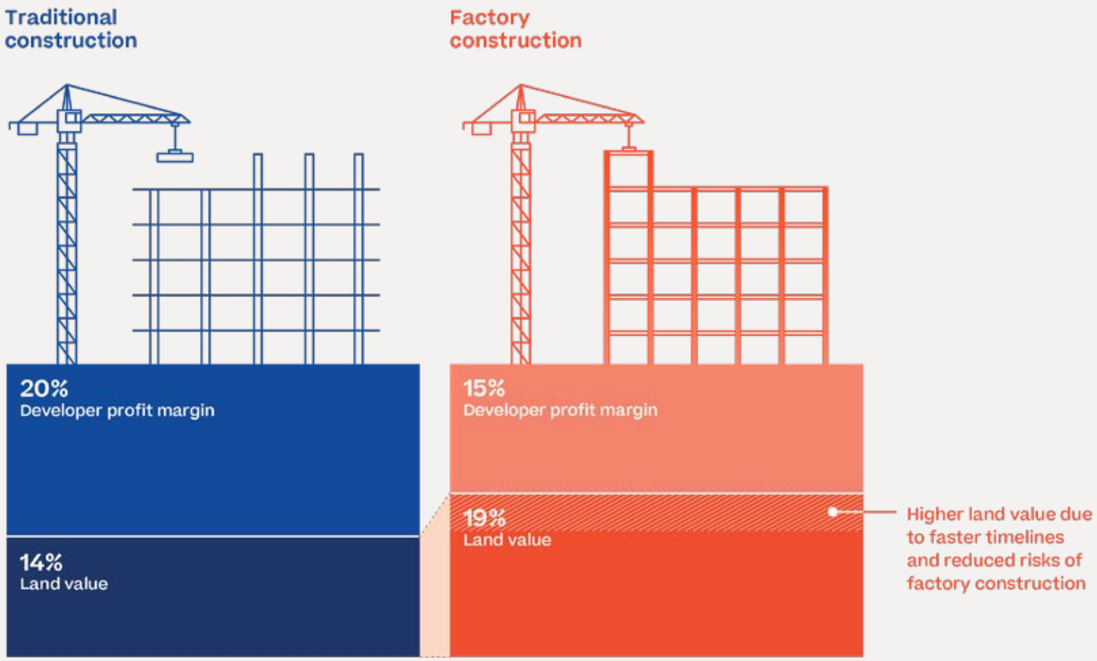
Research has shown, for example, that resale fees made common in New York City in the 1970s to generate capital for an aging housing stock did not lower prices.[71] But the resale fee in Quayside would not have sufficient time to provide capital sources to support the neighbourhood's housing program.

The resale fees generated in Quayside could also contribute to below-market housing at the full scale of the IDEA District. Assuming units in the project area are re-sold every seven years, consistent with existing trends in Toronto, Sidewalk Labs' proposal of a 1 percent fee on the resale value of each condo could generate a cumulative $321 million over 24 years for a 40 percent below-market program across the IDEA District.

That estimate would mean that each condo unit developed in Quayside carries the potential to deliver an estimated $23,000 towards below-market housing through 2048.

How factory-based construction can generate land value

Sidewalk Labs' plan to manufacture building parts could dramatically accelerate timelines and reduce risks for development projects. These benefits, once demonstrated in Quayside, would enable developers to pay more for land in the IDEA District, unlocking value that could be applied towards ambitious below-market housing programs.



Ground-up developers typically expect higher returns in exchange for taking on significant risk due to unpredictable project timelines and the need to find building materials at the right price.

Developers would be able to adjust their return expectations given faster project timelines and reduced risks. By realizing profits sooner, developers could benefit from higher "net present value" (money today is more valuable than money tomorrow) and have the opportunity to take on additional projects within the same time frame (such as doing three projects in six years instead of two).

Below-market housing impact

Potential value generated

$639M

Developers who recognize this value potential are willing to bid a higher price for the land. Across the proposed full scale of the IDEA District, this ability could generate an estimated $639 million in value for below-market housing (assuming the value is applied to publicly owned lands).

Note: Represents an illustrative and preliminary analysis on value generated by factory construction.

See the "IDEA District" chapter of Volume 3 for more details on the proposed public administrator role.

"Lock-boxing" funding with a Waterfront Housing Trust.

To help deliver new funding sources such as factory-based construction value or a condo resale fee, Sidewalk Labs proposes the creation of a housing trust fund: a new financial vehicle to assemble and disburse funding for below-market housing across the Sidewalk Toronto project area. (Sidewalk Labs would not participate in the trust's governance and proposes that it be publicly administered, potentially by the public administrator of the proposed IDEA District.)

The proposed Waterfront Housing Trust could assemble funding from a variety of public and private sources and "lock-box" this funding for below-market housing within the IDEA District, increasing the predictability and certainty of funding for developers from the outset of a project. Sidewalk Labs proposes that the Waterfront Housing Trust provide capital grants and other financial support for developers, both private and not-for-profit, seeking to meet significant affordability commitments.

The Waterfront Housing Trust would offer a replicable model for harnessing the private sector for affordable housing development.

A key advantage of the trust is flexibility. For example, in collaboration with government, the trust could disburse funding for mid-range (or middle-income) housing units in addition to affordable housing units, expanding the city's ability to meet affordability needs. Should it wish, a housing trust could also explore new funding concepts, such as an enclosed ecosystem for "cash in lieu" payments that ensures such payments go towards developments with below-market housing in the project area.

The trust also could incubate alternative funding sources as needed by the market, in addition to lock-boxing or capturing the value created by factory-based construction and condo resale fees.

For instance, the trust could create new low-cost debt financing products to better support affordable housing developers, or potentially incubate policy innovations less common in Toronto, such as air rights transfers from density bonuses. It could even attract new capital sources, as many North American cities have done, such as the New York City Acquisition Fund, which was launched in 2006 with public-private backing from the city, banks, and private foundations to provide early-stage financing for affordable housing developers.

The success of the Waterfront Housing Trust would offer a resilient and replicable model for harnessing the private sector for affordable housing development, and for creating mixed-income neighbourhoods elsewhere in Toronto, Ontario, and far beyond that could help communities offer more housing options to households of all incomes.

Traditional public sources

Sidewalk Labs' support of new private sources, including its approach to affordability by design, would reduce the reliance on government sources that would typically be needed to achieve an ambitious 40 percent below-market affordability target. But public programs remain essential to realizing affordable housing projects in Toronto.

Existing government programs.
To demonstrate one viable scenario, Sidewalk Labs examined two existing government programs that typically assist developers seeking to create affordable units in Toronto:

- National Housing Co-Investment Fund. The federal Co-Investment Fund run by the Canada Mortgage and Housing Corporation provides capital contributions and low-cost financing to developers of affordable rental housing.
- City of Toronto Open Door Affordable Housing Program. This program provides a mix of incentives, such as one-time exemptions from planning fees and development charges, as well as capital contributions.

To estimate the potential contribution of these two programs, Sidewalk Labs conducted financial testing and other analyses to compare their eligibility requirements with the MIDP's proposed housing program. (This analysis was based on past rewards and reasonable scoring performance, but it remains illustrative only.)

In Quayside, Sidewalk Labs estimates that these existing government sources could contribute an estimated $77 million towards a below-market program, including capital contributions and other incentives provided to developers.

But once new private funding sources become fully viable through the aforementioned factory or the condo resale fee, the proportionate need for these government sources would diminish.

More than 13,600 below-market units across the IDEA District

Delivering on a housing program at the proposed full scale of development across the IDEA District could create more than 13,600 below-market units, and roughly 34,000 housing units in all.

	Market housing (e.g. condo)	Below-market housing	Total
Percentage of program	60%	40%	100%
Number of units	20,400	**13,600**	**34,000**

Land value and other contributions.
To achieve a 40 percent below-market housing vision and truly set a new course for affordability in Toronto, additional public sources are needed after applying existing government sources.

While the government could fill this remaining need with whatever sources it deems appropriate, Sidewalk Labs believes there is precedent in Toronto for this funding need to be covered through adjusted land value, proceeds from land sales, or other contributions.

Land value is an essential component of the public-sector toolkit for affordable housing. In 2018, Toronto took an important step towards leveraging this public asset with the launch of CreateTO, an entity whose mandate includes reviewing the city's surplus land policies for affordable housing. The recent Housing Now initiative releases city-owned land to increase affordable housing, enabling land value to be considered a capital grant going directly to the creation of below-market units.

Today, at least six major revitalization initiatives already underway leverage city-owned lands to revitalize affordable rent-geared-to-income units. Government worked with Waterfront Toronto to leverage land value in the West Don Lands development;[72] for example, Phase 1 of that project provided "serviced and clean land" at no cost to support the development of affordable housing, ultimately leading to the creation of 243 new rental units.

Given its ambitious objective to deliver affordable housing along the waterfront, Waterfront Toronto's willingness to negotiate a price for the land in Quayside that recognizes these requirements is a critical component of filling the remaining cost gap of the proposed housing program.

At the full scale of the IDEA District, if the public sector chose to provide the remaining need for a 40 percent below-market program, the result would be more than 13,600 units of below-market housing, including some 6,800 units of affordable housing.

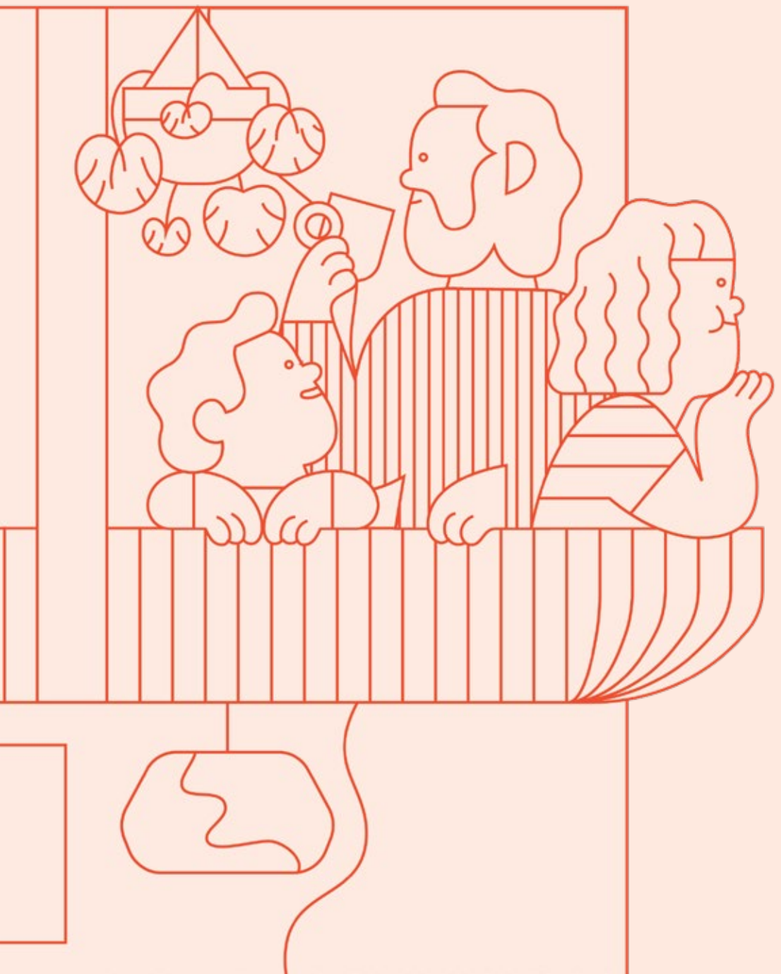
Consistent with Sidewalk Labs' proposed role as a catalyst, the new private sources unlocked by this approach to housing innovation would enable the IDEA District to realize far more below-market housing than the current 10 percent requirement for the private parcels on the eastern waterfront and Waterfront Toronto's commitment to set aside land sufficient to accommodate 20 percent affordable housing — providing a new model for other parts of the city and other cities around the world.

A comprehensive approach to affordability could help Toronto maintain its exemplary commitment to inclusion.

Ch–3

Public Engagement

The following summary describes feedback related to **buildings and housing**, and how Sidewalk Labs has responded in its proposed plans.



As part of its public engagement process, members of Sidewalk Labs' planning and innovation teams talked to thousands of Torontonians — including members of the public, expert advisors, civic organizations, and local leaders — about their thoughts, ideas, and needs across a number of topics.

1 Truly affordable housing for lower- and middle-income Torontonians

Members of the Sidewalk Toronto Residence Reference Panel discussing content for their interim report, published in September 2018. Credit: David Pike

What we heard

From the very first Sidewalk Toronto Town Hall, true housing affordability — especially for lower- and middle-income households — was top of mind for participants. Roundtable 4 participants particularly urged Sidewalk Labs to be ambitious with its affordable housing program. They felt units in Quayside should be lived in, rather than being luxury investment pieces.

Torontonians want Quayside to include diverse populations, with the buildings and neighbourhood representing a mix of incomes, ethnicities, and backgrounds. As one Reference Panel participant put it: "Issues of housing costs, community cohesion, making space for new arrivals — these are all really important in today's world. Toronto has a reputation for inclusiveness. I hope it stays that way." Participants emphasized the importance of providing a mix of housing options in Quayside, including significant numbers of rental units.

Participants were open to new models for the financing and operating of housing that could stand the test of time and encourage innovation. But Roundtable participants and the Residents Reference Panel wanted more clarity on building ownership and governance and the maintenance of buildings and appliances. The Housing Advisory Working Group generally supported the proposed affordable housing program, the shared ownership model, and the housing trust concept; it also encouraged the exploration of a digital affordable housing application and suggested that Sidewalk Labs find ways to empower and partner with non-profit housing organizations, without burdening them.

How we responded

Raising the bar.
Sidewalk Labs proposes that 40 percent of housing be below market, including new rental units specifically for middle-income residents. Sidewalk Labs proposes that 20 percent of all housing be affordable, consistent with the City of Toronto's definition of "affordable" housing as anything 100 percent of AMR and below (see Page 269).

Incorporating deep affordability.
Sidewalk Labs proposes that at least a quarter of affordable units go towards deep affordability for lower-income households at or below 60 percent AMR (see Page 269).

Collaborating with non-profits.
Sidewalk Labs plans to work with experienced non-profits to deliver the deep affordability component of its housing programs, inviting these organizations to participate in an exclusive proposal process and bringing them into the design process to help ensure that deeply affordable units meet the needs of inhabitants (see Page 273).

Supporting middle-income households.
Sidewalk Labs proposes that 20 percent of housing go towards middle-income households (100-150 percent AMR), creating new options for households currently left behind by the Toronto market but who do not qualify for affordable housing (see Page 270).

Helping families build equity.
Sidewalk Labs proposes a shared equity program that would enable middle-income households to own part of a unit (facilitated by a non-profit housing organization), reducing down payment costs and providing a more affordable path to home ownership. Five percent of all units would be earmarked for this program (see Page 274).

Providing rentals.
Sidewalk Labs proposes making half of all housing in Quayside purpose-built rental housing, improving long-term affordability for the city (see Page 269).

Enhancing applications.
Sidewalk Labs proposes to work with the City of Toronto to develop a new digital affordable housing application that could provide real-time transparency into the application process (see Page 277).

Expanding funding sources.
Sidewalk Labs proposes new financial and design tools that would help the private sector support government in delivering an ambitious affordability program, including value unlocked through factory-based construction techniques, a condo resale fee, and efficient unit design. Additionally, it proposes a new entity called the Waterfront Housing Trust to assemble public and private funding sources, "lock-boxing" them for below-market needs. (Sidewalk Labs would not play a part in the trust's governance.) (See Page 280.)

2 Explore innovative building designs

What we heard

Roundtable participants were enthused about mixed-use buildings and open to innovative construction and design. As one visitor to Sidewalk Labs' Toronto headquarters, 307, said: "Every time I go to a meeting, it's been the same design for buildings in the last 30 years. It seems you have the capacity and the interest to push for new innovation and that's exciting."

Torontonians want the neighbourhood to feel human scale (no super high-rises) and be accessible for those with limited mobility. They were also supportive of healthy, natural building materials; they generally liked the biophilic, low-carbon nature of timber, although they expressed concern about the safety, durability, and toxicity of the material.

Participants in the tall timber industry events similarly questioned the long-term maintenance of the material and the extent to which the industry will buy-in and be able to respond to this new demand. But overall, they were excited about the potential of prefabricated timber construction to increase efficiencies, decrease costs, improve and speed up assembly, and generate safe, high-quality buildings.

The Housing Advisory Working Group was similarly excited about the potential of modular housing, while also questioning its viability and cost. They recommended that Sidewalk Labs work closely with the city on zoning regulations to make the mixed-use vision a reality.

How we responded

Enabling mixed-use.
Sidewalk Labs proposes to use and require a real-time building code system that could enable a mix of residential and non-residential uses without sacrificing safety or quality of life (see Page 251).

Designing for adaptability.
Sidewalk Labs plans to include a loft-style approach to buildings, with floor plans and spaces that can be easily adapted for occupancy with many different types of uses, reducing the time and cost of renovating a space (see Page 246).

Creating modularity.
Sidewalk Labs plans to create a pre-designed library of parts for construction that would reduce time spent on designing and sourcing materials, improving cost and time predictability while still enabling design excellence (see Page 220).

Building green.
Sidewalk Labs commits to using formaldehyde-free glues for its mass timber elements, and to pursuing glues and finishes that are Cradle-to-Cradle certified (see Page 212).

Ensuring safety.
To ensure the safety of all structures in Quayside, Sidewalk Labs plans to work with Equilibrium, a Vancouver-based structural engineering firm experienced in timber construction; Aspect Structural Engineers, a firm based in Vancouver; Michael Green Architects; CHM Fire Consultants, based in Ottawa; Vortex Fire Consulting, a global fire-code consulting firm with offices in Toronto; Gensler Architects, with an office in Toronto; Golder Associates LTD, based in Toronto; and Integral Group, a building system engineering firm with an office in Toronto.

Scaling for people.
While zoning for the Quayside site permits taller buildings, Sidewalk Labs plans to limit its buildings to around 30 storeys to create a more human-scale neighbourhood (see Page 231).

Incorporating accessibility.
Following its accessibility principles, Sidewalk Labs plans to design buildings that make threshold moments accessible (such as using automatic doors) and, when possible, make walkways wide enough for people to talk to each other while signing (see Page 106).

Engaging partners.
Sidewalk Labs created a forum for a wide array of players from the mass timber industry — including contractors, designers, manufacturers, and union leaders — to discuss the technical challenges of building with the material, develop potential solutions, identify opportunities for collaboration, and support the growth of this local industry (see Page 217).

Attendees of the "Open Sidewalk: Nature and the City" event explore a mass timber exhibit at 307. Credit: Jenna Wakani

3 Create units that can adapt over time and encourage neighbourliness

What we heard

Participants were enthusiastic about flexible unit designs that could adapt according to different life stages; they also expressed interest in larger units (two bedrooms or more) that could accommodate growing families and generations living together. The Family Lifestyles Research also illuminated some of the challenges facing families, who often desire (but cannot find) apartments with ample kitchens or living rooms, multiple bedrooms, and storage solutions.

Many Torontonians were generally open to sacrificing some square footage within their individual units for shared amenities, spaces (like communal kitchens, laundry rooms), and goods (like strollers or tools), especially as this sharing could generate more community bonding. Participants in the Seniors Workshop liked the idea of having multiple generations, and an active community, in one's building. As one senior requested: "Create a porch condition outside my front door."

Of course, even with a strong community, in-unit storage and enough space for personal expression is crucial, as visitors to the Efficient Unit Prototype at 307 noted. Prototype visitors also recommended making units more accessible by integrating adjustable counter and appliance heights. Others recommended ensuring that finishes are customizable and that partitions are genuinely easy to remove, so tenants can have more agency over their homes.

How we responded

Facilitating expansion.
Sidewalk Labs plans to implement a flexible interior wall system, where sections of walls can be easily clipped into place or removed, thus making renovation (expansion or contraction) easier and more affordable (see Page 246).

Welcoming families.
Sidewalk Labs plans for 40 percent of total units to have two bedrooms or more, creating new options for families (see Page 253).

Designing flexibility.
Sidewalk Labs has worked with nArchitects to explore efficient unit designs globally and with Toronto-based gh3 on a unit prototype to explore how efficient designs could meet the needs of shifting demographics in Toronto. This research, coupled with feedback on the Efficient Unit Prototype, would inform final unit design. Current designs include multi-purpose tables that could be raised or lowered when not in use, lofted beds located up short staircases that could double as storage drawers, and countertops that could serve as cutting boards (see Page 255).

Optimizing storage.
Sidewalk Labs proposes efficient units be designed to have less in-unit storage space than a market comparison apartment, compensated with free in-building storage and additional off-site storage with low-cost, on-demand delivery (see Page 255).

Exploring co-living.
Sidewalk Labs plans to provide a co-living option (efficient units with shared building amenities and community programming) for residents who prefer more communal living (see Page 260).

Strengthening community.
Sidewalk Labs plans to create abundant public space and allocate 90,000 square feet to social infrastructure, providing the spaces and programming tools to inspire a stronger community (see the "Quayside Plan" chapter of Volume 1).

Incorporating accessibility.
In keeping with its accessibility principles, Sidewalk Labs commits that 20 percent of units would have accessible fixtures and pledges to meet the evolving and growing housing needs of seniors.

Engagement spotlight

Community members share feedback during the "Re-Imagining Homes for Seniors" workshop. Credit: Sidewalk Labs

In September 2018, Sidewalk Labs convened individuals from 17 non-profits — including leaders in social service provision and housing for women, Indigenous communities, and homeless populations — for a roundtable. Sidewalk Labs Associate Director of Development Annie Koo was eager to learn from these leaders about how best to work with them on a deeply affordable housing program.

Initially, Annie had been considering a kind of non-profit bootcamp or fellowship program — a kind of incubator to which non-profits could apply and then receive funding or support. But one participant explained that the time commitment of such a program — while well-intentioned — would be particularly onerous for resource-strapped non-profits.

"So we course-corrected," says Annie. "We heard loud and clear. We want to partner with you, but don't add to our challenges. Meet us where we are." In response, Annie and her team simplified the concept to be a proposal process — exclusive to nonprofits — for organizations to design and deliver the deep affordability component of housing at Quayside.

Acknowledgements

Sidewalk Labs would like to extend special thanks to the participants of the Sidewalk Toronto Housing Advisory Working Group, and to the staffs of the City of Toronto, Province of Ontario, and Government of Canada for their time and guidance.

Endnotes

General note: Unless otherwise noted, all calculations that refer to the full proposed IDEA District scale are inclusive of the entirety of its proposed geography, including all currently privately held parcels (such as Keating West). Unless otherwise noted, all currency figures are in Canadian dollars.

Charts note: Sources for the charts and figures in this chapter can be found in the accompanying copy for a given section; otherwise, the numbers reflect a Sidewalk Labs internal analysis. Additional information can be found in the MIDP Technical Appendix documents, available at www.sidewalktoronto.ca/midp-appendix.

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Chapter 4

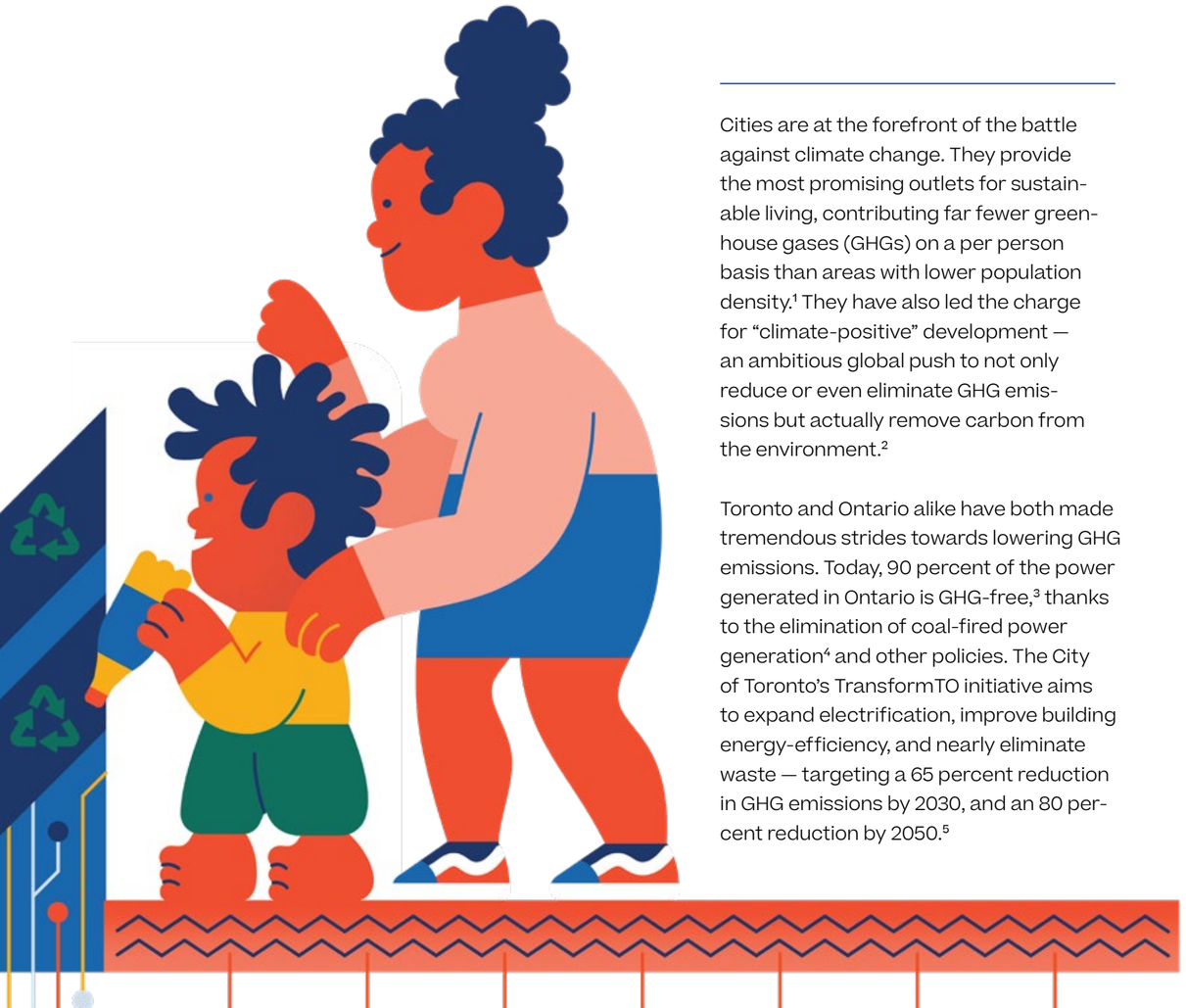
Sustain-ability

Ch–4

Introduction

The Vision

A new standard of **sustainability** that creates a blueprint for truly **climate-positive communities.**



Cities are at the forefront of the battle against climate change. They provide the most promising outlets for sustainable living, contributing far fewer greenhouse gases (GHGs) on a per person basis than areas with lower population density.[1] They have also led the charge for "climate-positive" development — an ambitious global push to not only reduce or even eliminate GHG emissions but actually remove carbon from the environment.[2]

Toronto and Ontario alike have both made tremendous strides towards lowering GHG emissions. Today, 90 percent of the power generated in Ontario is GHG-free,[3] thanks to the elimination of coal-fired power generation[4] and other policies. The City of Toronto's TransformTO initiative aims to expand electrification, improve building energy-efficiency, and nearly eliminate waste — targeting a 65 percent reduction in GHG emissions by 2030, and an 80 percent reduction by 2050.[5]

These and other ambitious programs have helped Toronto reach per capita emissions of 6.3 tonnes per year.[6] But Waterfront Toronto wants to do even better with new developments under its stewardship, and has established a public policy goal of achieving a climate-positive community along the eastern waterfront that can demonstrate a path forward for other large-scale urban developments to follow.

The Sidewalk Toronto project provides a unique opportunity — at a moment of renewed urgency — to tackle climate challenges. Incremental changes have been unable to eliminate GHG emissions, let alone achieve climate-positive development in a replicable way. Instead, reaching this goal requires a comprehensive approach to designing, operating, and managing energy systems that integrates new physical infrastructure with emerging digital tools.

At the core of this approach is using clean electricity for all heating, cooling, and power needs. Today, Toronto's buildings account for roughly 60 percent of the city's GHG emissions,[7] with the vast majority of those emissions (87 percent) attributed to burning natural gas for heat or hot water.[8] In other words, the clearest path towards positivity is through full electrification. But electricity could become more expensive for households and businesses, given that electricity tends to cost more than natural gas, unless a system were deployed at a wide enough scale to spread the costs.

The innovation plan.

Building on concepts from Waterfront Toronto's existing precinct plans, Sidewalk Labs proposes a six-part pathway to achieve climate-positive development that can only be effective and financially feasible when applied across a broad area and supported by strong cooperation between the public and private sectors.

First, Sidewalk Labs proposes to reduce overall energy demands through energy-efficient building designs. These designs would maintain interior comfort by incorporating building features inspired by the global "Passive House" movement, such as airtight wall systems. These proposed designs would achieve or exceed the highest levels of the Toronto Green Standard (the city's energy code) for GHG intensity.

Second, Sidewalk Labs plans to eliminate energy waste through digital management tools. A proposed suite of energy "Schedulers" would actively manage energy systems for residents, businesses, and building operators, ensuring that buildings operate in the most efficient way possible.

Third, Sidewalk Labs plans to use a district energy system called a "thermal grid," which could provide heating, cooling, and domestic hot water without relying on fossil fuels. This grid harnesses clean energy from a variety of sources — including geothermal (underground) energy, building waste (or excess) heat, and wastewater (sewage) heat — and operates using electric heat pumps, eliminating the need for boilers powered by natural gas.

Benefits of implementing the vision

- Establish a global model for achieving climate positivity
- Reduce carbon emissions by 89 percent over the current city average
- Improve recycling and organic waste processing, with a landfill diversion rate of 80 percent
- Protect water quality, lower costs, and create a more beautiful public realm through a green stormwater system

Fourth, Sidewalk Labs proposes to design an advanced power grid that uses solar energy, battery storage, and real-time energy pricing to reduce reliance on the main power grid during periods of peak demand, when the grid requires fossil fuels to meet needs. This grid could draw on solar or battery energy at peak moments or, combined with the Schedulers mentioned above, defer energy consumption until off-peak hours, when fossil fuel-fired power plants are not in use.

Fifth, to reduce GHG emissions from garbage trucks and the impact of landfill waste, Sidewalk Labs proposes a smart disposal chain that could dramatically improve recycling rates and organic waste processing. This chain would include real-time feedback to improve waste sorting, "pay-as-you-throw" chutes that encourage households and businesses to reduce waste, underground vacuum tubes that help reduce contamination and centralize trash hauling, and connections to anaerobic digestion facilities.

Finally, to protect the water quality along the waterfront while also incorporating more nature into the public realm, Sidewalk Labs proposes a combination of green infrastructure and digital stormwater management systems that could help capture, reuse, and, if necessary, treat stormwater that might otherwise contaminate the Don River basin.

The Sidewalk Toronto project could become the largest climate-positive district in North America.

The impact.

Together with mobility initiatives that encourage cycling, walking, and the use of electric vehicles, this comprehensive plan represents a dramatic reinvention of how major infrastructure systems are built and operated, as well as the way energy is generated, managed, and consumed — all in pursuit of the greater goal of climate-positivity.

In Quayside, Sidewalk Labs estimates that this integrated plan could make the neighbourhood nearly carbon neutral, achieving per capita emissions of slightly over 0.9 annual tonnes.[9] That represents a reduction of more than 85 percent from Toronto's citywide average, the equivalent of removing over 100,000 cars off the road each year. But the initiatives proposed in Quayside are only economically feasible when part of a broader approach that spans a large enough development area to support inventing, implementing, and operating this new sustainable energy ecosystem.

At the proposed full scale of the IDEA District, Sidewalk Labs estimates achieving emissions of 0.7 annual tonnes per capita, or an 89 percent reduction from the city's current average.

That scale represents a sufficient size to amortize the capital costs of major new infrastructure and keep utility bills comparable to existing standards for households and businesses.

This broader scale also makes it possible to achieve Waterfront Toronto's climate-positive objective. At the full scale of the IDEA District, in collaboration with the city, it could become economically feasible to tap into the Ashbridges Bay Wastewater Treatment Plant, a source of clean energy potential unmatched across North America. The energy potential of Ashbridges would create a surplus of clean energy in the project area that could then be exported to buildings in other parts of the city — fulfilling the mandate of climate positivity by reducing the city's overall emissions.

With public-sector support, the Sidewalk Toronto project could become the largest, densest climate-positive district in North America and the third largest in the world[10] — establishing a credible path forward for cities to follow.

IDEA District

The 77-hectare Innovative Design and Economic Acceleration (IDEA) District, consisting of Quayside and the River District, provides sufficient geographic scale for innovations to maximize quality-of-life impact and to become financially viable.

The path to achieving a climate-positive district

Sidewalk Labs has proposed a set of on-site and off-site initiatives that, when combined, would produce the largest climate-positive district in North America.

Sidewalk Labs estimates that, at the proposed full scale of the IDEA District, all the sustainability initiatives described in this chapter, combined with planned mobility initiatives, would reduce GHG emissions to 0.72 annual tonnes per capita, or roughly 89 percent less than the city's current average of 6.3 annual tonnes.

These efforts would make Quayside a nearly carbon-neutral neighbourhood, and make the proposed full scale of the IDEA District even closer to carbon neutrality. But these initiatives alone cannot realize a climate-positive community, because achieving that goal requires exporting clean energy or actively reducing Toronto's current GHG emissions.

Achieving the goal of exporting clean energy would require both a large scale of development and the strong partnership of the city, but it is possible. The best path Sidewalk Labs has found is to tap the large store of energy in Toronto's own wastewater, which would allow the proposed heating and cooling system to serve areas beyond the project borders. Such an effort would be as ambitious as Toronto's "deep lake water cooling" project was 20 years ago, and it would fulfill a climate-positive vision that not only benefits Toronto but provides a model for other cities around the world.

Tapping the full potential of wastewater from Ashbridges Bay would enable the project to give back 70,444 annual tonnes of CO2, or nearly 1.31 tonnes per person. Sidewalk Labs could achieve an additional 0.1 tonnes per capita offset through the creation of biogas from anaerobic digestion.

The role of mobility plans in reducing GHGs.

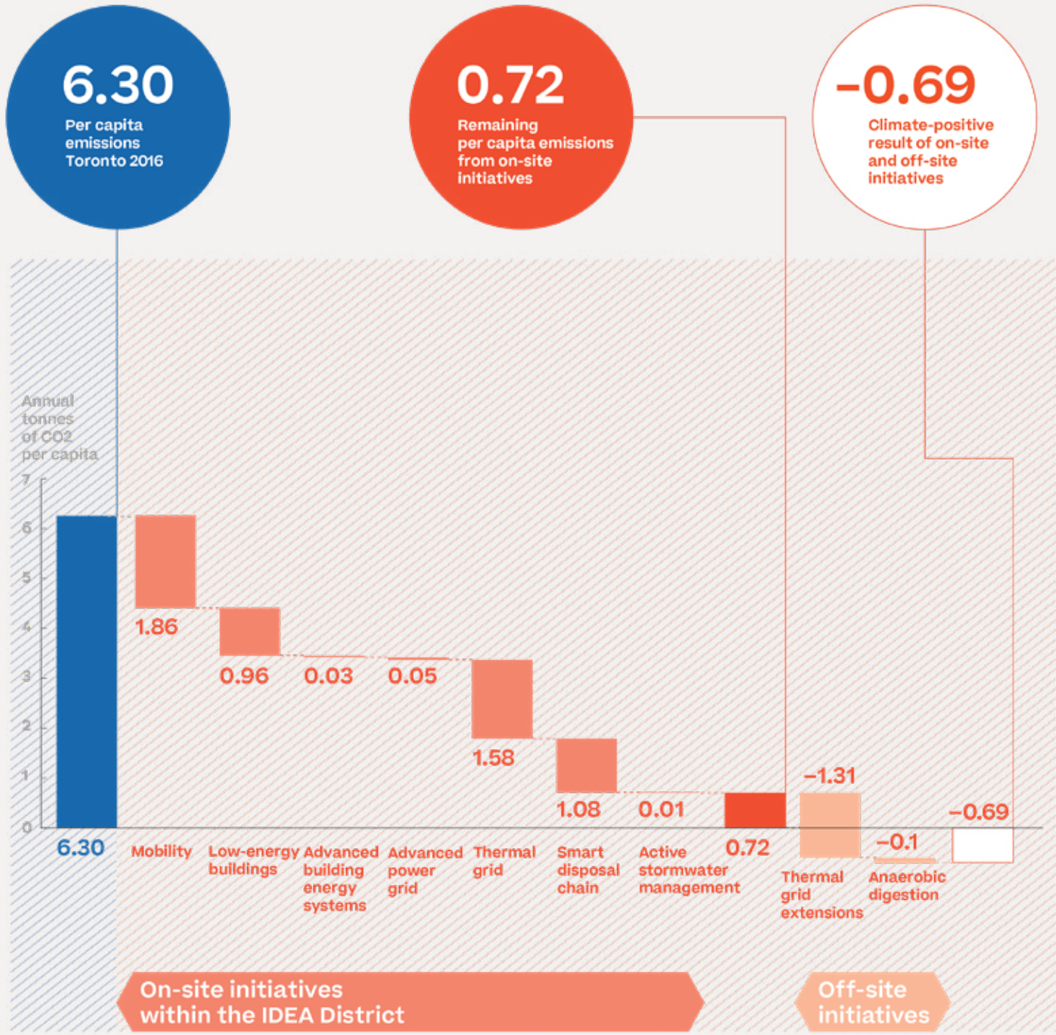
Sidewalk Labs' approach to mobility also plays a key role in realizing a climate-positive goal by providing alternatives to private automobile use, which is the second-largest source of Toronto's GHG output.[11]

Given the proposed light rail extension, walking and biking options, shared vehicle services, and mobility management system, this plan would translate into an estimated 30 percent reduction due to mobility-related GHG emissions.

Additionally, by encouraging electric vehicles, Sidewalk Labs expects that 30 percent of all the vehicle kilometres travelled by residents would be by electric vehicles in Quayside, and up to 100 percent across the IDEA District over time.

Altogether, these efforts would reduce transportation-related GHG emissions by 1.86 tonnes per capita at the full scale of the IDEA District.

See the "Mobility" chapter in Volume 2, on Page 22, for the full electric vehicle plan.



Note: Because the estimated GHG reductions shown here are based on a combination of design, technology, and behaviour change, Sidewalk Labs expects unforeseen shortfalls at the neighbourhood scale of Quayside.

The sustainability systems proposed in this plan include self-correction and learning mechanisms (such as advanced energy management tools and a smart disposal chain) that should reduce these variations as development proceeds across the IDEA District.

As a result, Sidewalk Labs has reduced the sustainability plan's expected GHG outcomes 10 percent in Quayside and 5 percent at the full scale of the IDEA District.

Ch–4

Part 1

Creating Low-Energy Buildings

Key Goals

1
Deliver Passive House–inspired buildings

2
Improve modelling through real-time metering

3
Use digital tools to tie energy outcomes to energy codes

The first step towards achieving a climate-positive community starts with reducing how much energy building tenants need to heat and cool their homes and offices.

While there are many potential sources of high energy usage, two stand out. One is inefficient building designs and construction quality, which waste opportunities to conserve energy and improve comfort. The other is the inability of cities to determine how well energy is managed in a building once it is in actual operation. Instead, cities use models based on pre-construction design drawings to determine whether or not a building meets energy code, with no way to ensure a building's *actual* energy performance meets its *expected* energy performance.

Toronto and Ontario have made strides to tackle these challenges. The Toronto Green Standard (TGS), the city's sustainable design requirements for new development, sets targets for measurements such as energy use intensity and GHG intensity that get progressively more ambitious over time. TGS includes four tiers of performance, with Tier 1 as a code requirement, Tier 2 as a stretch goal with incentives, and Tiers 3 and 4 voluntary higher levels working towards zero emissions. And in February 2017, Ontario passed Energy and Water Reporting and Benchmarking legislation, in an effort to better track building energy use.[12]

But a study commissioned by Sidewalk Labs found that buildings in Toronto have not performed in line with modelled projections, using 13 percent more energy than modelled on average. The study also sampled 95 multifamily buildings that sought code compliance between 2015 and 2017; while these projects were not obligated to meet the new TGS targets, which went into effect in May 2018, only 5 percent would meet the equivalent of today's TGS-Tier 1 target for energy use intensity. (See Page 311 for more study details.)

Such results suggest that buildings in cities around the world, including Toronto, are struggling to keep pace with energy-efficiency goals, let alone exceed them.

Improving construction quality and tightening building design standards can conserve energy while preserving comfort for tenants.

To help improve building energy performance, Sidewalk Labs proposes to require that all buildings in the Sidewalk Toronto project area meet rigorous energy-efficient building design standards inspired by the Passive House movement, and plans to apply its factory-based approach to improve construction quality. Sidewalk Labs also proposes to develop new digital tools for evaluating energy performance in real time and implementing operational improvements as a critical step towards significantly reducing energy demands within the IDEA District.

At the scale of Quayside, this approach would produce buildings that meet the latest TGS-Tier 3 standard for energy use intensity and Tier 4 for GHG intensity. In Quayside, this achievement would reduce building energy use by 40 percent and GHG emissions by 75 percent over TGS-Tier 1 construction.

At the proposed full project scale, energy-efficient designs — reinforced by real-time energy measurements — could reduce GHG emissions by 0.96 annual tonnes per capita (or 15.2 percent) from the city's current average, on the path towards climate positivity.

Meeting Toronto's highest building sustainability standards

The Toronto Green Standard sets targets for new development around total energy use intensity, greenhouse gas intensity, and thermal energy demand intensity. Across all three measures, the Sidewalk Labs proposal meets ambitious TGS targets, outperforming the industry standard.

Goal 1

Creating Low-Energy Buildings

Deliver Passive House-inspired buildings

A Passive House approach to building design maintains a comfortable interior temperature "passively" — that is, with less need for active heating and cooling devices.

Low-energy buildings could reduce GHG emissions by

0.96

annual tonnes per capita.

A Passive House uses substantial wall insulation, airtight exteriors, and higher-quality windows to maintain a consistent, comfortable interior temperature. Ventilation systems circulate fresh, filtered outside air, while recovering heat from older, stale air before it is removed. Together these efforts reduce the "loads" of buildings — heating, cooling, ventilation, and other systems needed for people to be comfortable.

While this approach is not new, and in fact has deep roots in Canada (see sidebar on this page), Passive House has been applied to multifamily structures more frequently in relatively recent years.

For the IDEA District, Sidewalk Labs proposes to establish construction design standards inspired by Passive House and consistent with TGS-Tier 3 performance targets. These design standards would focus on envelope insulation, thermal bridging, air tightness, balanced ventilation, and unconditioned shared spaces. (See the visual on Page 308.)

Low-load buildings could reduce GHG emissions by 15.2 percent or nearly 95,500 tonnes — equivalent to removing more than 20,000 cars off the road.

Innovation case study

Passive House's Canadian roots

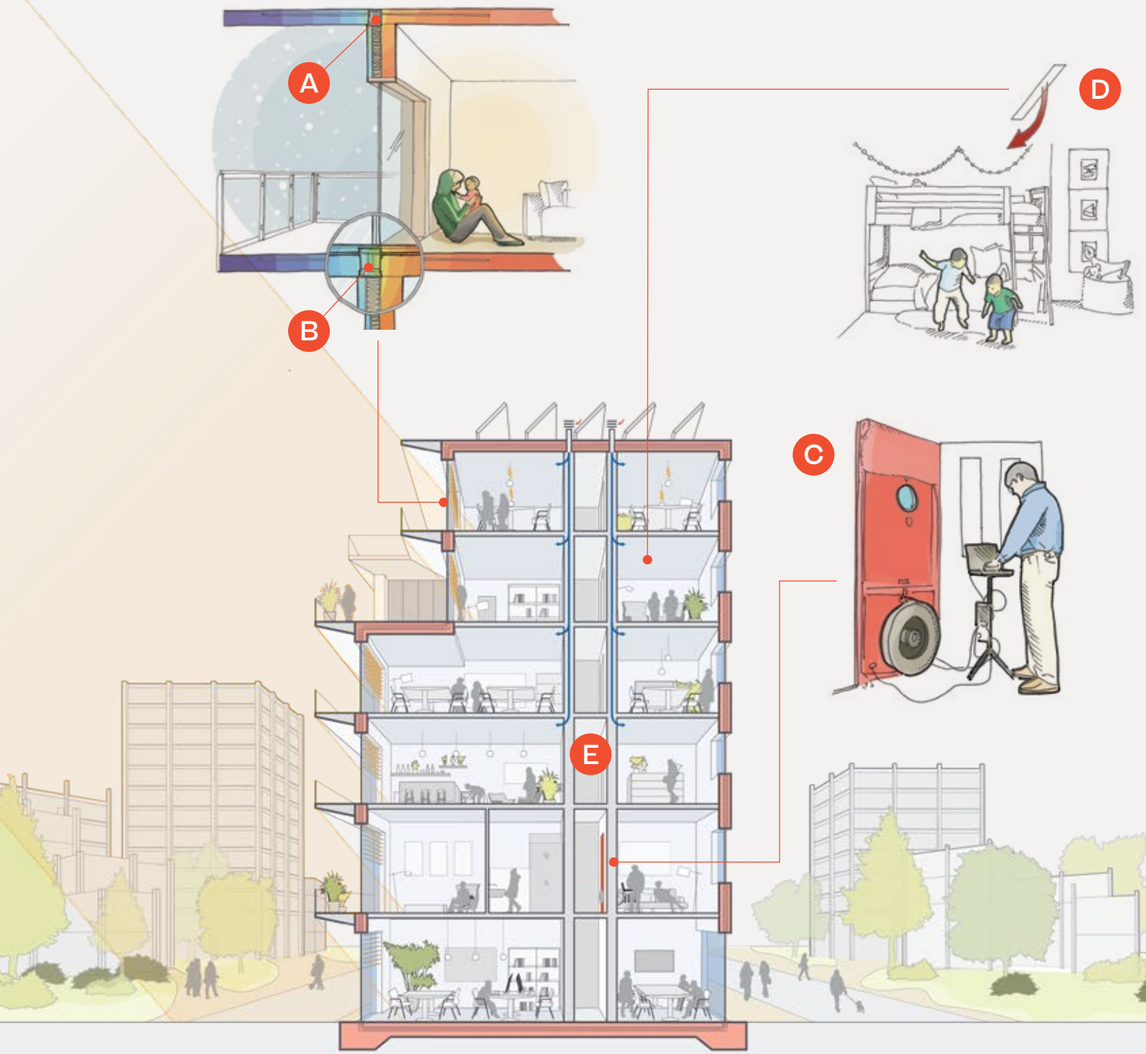
Passive House is the most rigorous voluntary standard for energy efficiency in the design and construction industry. The standard is established, maintained, and promoted globally by the Passivhaus Institut in Germany, with satellite associations in countries around the world.

While the Passivhaus Institut was founded in 1996, the Passive House movement has its roots in Canada — specifically in the 1977 construction of the Saskatchewan Conservation House in Regina, built as a response to the OPEC oil crisis. Using triple layers of insulation and windows oriented to capture sunlight, Conservation House heating requirements were only 1/28th of the average Regina home.[13]

Today, projects built according to the Passive House standard use the latest technologies in window design, panellized construction, insulation, and air sealing, and can range from detached homes to multi-storey towers. The world's largest Passive House building — a 26-storey dorm on the Cornell Tech campus in New York City — opened in 2017.[14]

Five design strategies to create low-energy buildings

Smarter building designs can lower the amount of energy required to heat, cool, and ventilate buildings, while keeping interiors just as comfortable for tenants. That approach includes improving insulation around the building, preventing unwanted air leaks and heat loss, venting fresh air, and applying passive comfort methods to shared spaces.



A Envelope insulation.
In standard buildings, gaps in envelope insulation can lead to unintended interior temperature changes. Sidewalk Labs proposes to require highly insulated building "envelopes" — basically, walls designed to resist heat loss and preserve interior temperature, like a thermos. This continuous insulation prevents the unwanted interior-exterior exchange of heat or cooling (known as "thermal bridging"). Sidewalk Labs would also provide criteria for window designs to reduce heat loss in winter and heat gain in summer.

B Thermal bridging.
Heat in a building finds the path of least resistance to cold outside air. If there is a pathway for the heat to transfer, it transfers — for example, steel-reinforced concrete slabs can transfer heat from the inside of a building to the exterior, which can be the reason some parts of some rooms always seem colder than others. In addition to ensuring continuous insulation, Sidewalk Labs plans to add gaskets and manufactured "thermal breaks" (non-conductive inserts in a chain of conductive materials) to stop building heat from escaping unintendedly.

C Air tightness.
In standard buildings, even small air leaks can cause drafts and interior temperature changes that lead to greater heating and cooling needs. These leaks often come from basic construction errors, such as incomplete caulking around a window or pipe penetration through a wall.

To meet Sidewalk Labs' energy-efficient standards, buildings would need to significantly reduce air leakage around windows, doors, and mechanical systems using airtight designs, along with other measures, such as special tapes and sealants. Factory-produced building parts that snap into place can also help limit air leakage. During construction, infrared cameras can help detect tiny air leaks.

The target rate of air tightness would be a maximum of 0.6 air changes per hour (at 50 Pascals pressure), as prescribed by Passive House.[15] To ensure this rate is achieved, Sidewalk Labs proposes to require Passive House-inspired air infiltration testing after construction. This testing is typically done through a "blower door test": fans are placed in doorways to blow air inside and pressurize the building, which is then measured for how well it holds this new pressure.[16] If the test fails, the contractor must identify and correct the source of air leakage, or the building cannot be certified.

D Balanced ventilation.
Sidewalk Labs proposes to require buildings to vent fresh air directly to living areas and bedrooms (in residential units) and to office or retail spaces (in commercial units). One way to achieve this goal is with a ventilation system that has two ducted air streams: one provides filtered, outdoor air to living areas, and one removes older, stale air from warmer rooms, typically bathrooms or kitchens.

Additionally, Sidewalk Labs proposes to require building ventilation systems to have "heat recovery" devices to transfer heat between the warm and cool air streams. On cold days, this system would transfer warmth from the older interior air to help the cool outdoor air reach the desired temperature with minimal energy use; on hot days, the system would transfer warmth and moisture from the incoming hot and humid outdoor air to the exhaust air, cooling and drying the new air supply and reducing the need for supplemental air conditioning.

E Unconditioned shared spaces.
Traditional buildings provide continual air conditioning or heating to transitional spaces, such as corridors and lobbies, regardless of the actual occupancy of these spaces, wasting an enormous amount of energy in the process. Sidewalk Labs' buildings would not provide continual conditioning to these spaces, but rather rely on heat exchange in building ventilation systems to keep a comfortable temperature, requiring no additional conditioning. (Corridors would be designed to easily add systems to condition air in these spaces if necessary.) Buildings would include small lobbies that offer a blast of cold-air as people enter or exit.

Goal 2

Improve modelling through real-time metering

Designing Passive House-inspired buildings should reduce their energy demand. But if the design details, construction quality, and systems operation are different in practice from what is initially planned, the building's actual energy use in operation can be far greater than shown by a model submitted for energy code compliance.

This disconnect is known as the "performance gap." In its study of nearly 100 buildings in Toronto, Sidewalk Labs found the performance gap to be 13 percent, meaning buildings use more energy when actually up and running than when modelled prior to construction.[17]

That overall performance gap belies a number of much larger gaps from a variety of sources (see charts). The study found that, on average, multifamily buildings in Toronto are using 39 percent more gas for heating, 21 percent more gas for domestic hot water generation, 61 percent more energy for pumping, and 94 percent more energy for common areas than modelled.

Meanwhile, the study found that residents used 26 percent less electricity than projected — likely due to outdated plug load guidelines in the code, which date back to 1997, but also possibly due to inaccurate occupancy assumptions (meaning units were unoccupied more often than the model suggested). It also found that cooling energy was 26 percent less than modelled.

The diagnosis for these gaps includes optimistic modelling of exterior wall construction and underrepresenting heat loss through metal components that bridge exterior walls and roofs, as well as incorrect assumptions about the operation and energy intensity of building systems and equipment.

To help improve energy modelling, Sidewalk Labs first plans to incorporate findings from its study into modelling assumptions. Further, Sidewalk Labs proposes that buildings in the IDEA District be required to deploy real-time metering of all energy systems (such as heating, cooling, lighting, and equipment). This ongoing measurement could help to improve the accuracy of building modelling two ways: first, by providing feedback on how tenants and operators actually operate systems in practice, and second, by enabling comparisons between the energy performance of those systems and the design-based projections.

Over time, the availability of real-time building energy data should dramatically improve the accuracy of performance-based models used to validate building codes. It should also create a feedback loop of performance to help architects, engineers, and developers improve their next designs — and, in so doing, help close the performance gap and improve the energy efficiency of buildings.

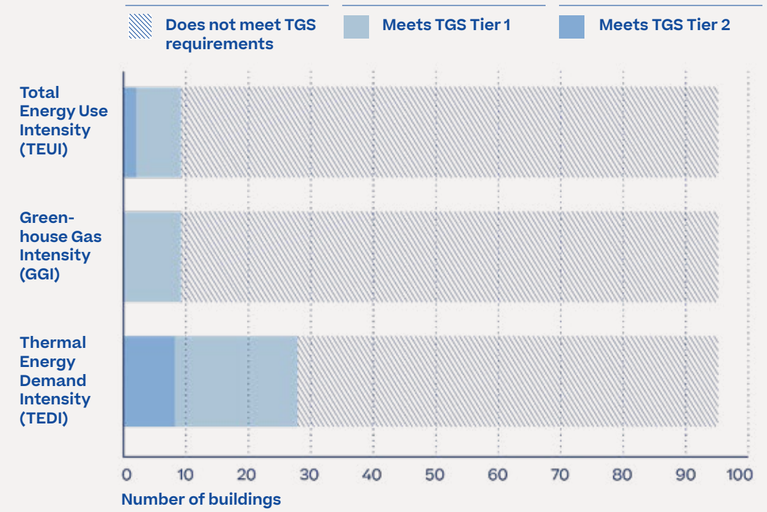
All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the "Digital Innovation" chapter of Volume 2, on Page 374.

Analyzing the challenges to sustainable development

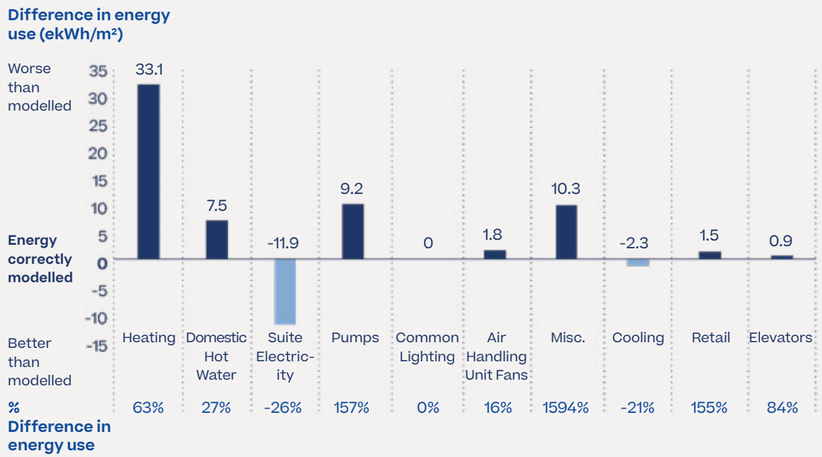
Sidewalk Labs engaged EQ Building Performance and Urban Equation to understand how design-based energy models differ from actual building energy performance in Toronto. The full report can be found at sidewalktoronto.ca.

Only 5% of buildings would meet new TGS-Tier 1

One aspect of the study looked at 95 multifamily buildings whose energy use was modelled between 2015 and 2017. All the buildings conformed to Tier 1 of the Toronto Green Standard code at the time the models were generated. But the study found that only 5 percent of the buildings analyzed would meet the new version of TGS-Tier 1 across categories, and none met all of the criteria for Tier 2, the city's first level of stretch goal beyond code.



Across many building systems, actual energy use does not match predicted use



This chart comes from a sub-sample analysis of 19 buildings already in operation from the Sidewalk Labs building study. For these buildings, the median metered (or actual) energy use intensity was 13 percent higher than the energy use intensity projected by the original models, or a total of about 50 energy units (ekWH/m2). This performance gap was supported by larger data sets: the average energy use intensity of 83 existing buildings (age 1998–2017) was 12.5 percent higher than the average energy use intensity of 95 models (2015–2017). The chart shows the various sources of this gap across building energy systems.

Real-time building energy data can help architects, engineers, and developers create more energy-efficient designs and close the performance gap between a building's projected and actual energy use.

Goal 3

Use digital tools to tie energy outcomes to energy codes

Even as real-time metering would help to close the performance gap and inform better building design, cities still need the ability to audit energy performance once a building is in operation, and create more responsive codes.

To help tackle this challenge, Sidewalk Labs proposes to develop and deploy a tool called "Perform" that would enable more effective enforcement of energy targets. Perform could incorporate factors that have an outsized impact on energy use, such as occupancy, tenant type, and weather, to create dynamic targets for acceptable energy use intensity. For instance, the tool would know that if the building is unoccupied in the evening, it should be using a fraction of the energy that it uses during the day.

Creating a system that could account for building use and tenant type would be essential, because some tenants use more energy than others for good reasons. For example, a building floor filled with video graphic artists using multiple screens and high-performing computers all day would likely consume more energy than a painter's art studio. Measuring precise patterns across various tenant types can help inform more realistic goals for energy usage in buildings that have a mix of homes, offices, and shops, and can help determine how to balance individual tenant goals with overall city and community goals.

If Perform were validated in practice in Quayside, Sidewalk Labs would plan to work with the city to require a tool like it with the IDEA District and to establish operational energy limits based on real-time metering for new buildings — not on pre-construction designs. At the full scale of the IDEA District, with a large number of buildings, this tool could form the basis for a real-time energy code that adjusts dynamically for occupancy, tenant type, and weather to ensure fair and appropriate energy use regulation.

All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the "Digital Innovation" chapter of Volume 2, on Page 374.

Ch–4

Part 2

Optimizing Building Energy Systems

Key Goals

1
Create automated "Schedulers" for offices, homes, and building operators

Reducing overall energy demands through low-energy building designs and real-time energy measurement tools represents an important first step on the path towards climate positivity. But designs are not enough if buildings do not operate in an energy-efficient way — say, if the air conditioning stays on full blast when no one is around.

Three main groups are responsible for a building's energy use on a daily basis:

Office tenants seemingly control their space and all of the energy uses associated with it. But in practice, office tenants actually control very little in their space. Commercial thermostats are often remotely controlled and require a call to the facilities manager or building operator for adjustment. Ventilation fans often run on whatever schedule the building operator has set. And equipment and devices are commonly left on because no one is in charge of turning them off.

Residents typically control thermostats for heating and cooling, lighting, and plug loads in their units. Leaving the lights on or setting a thermostat too high are decisions that can add up to significant energy waste. Additionally, residents may unconsciously operate electric appliances during times of peak power demand (when GHG intensity is highest, and utility prices are also highest) that could run later without impacting their schedule.

Building operators make dozens of decisions about how to manage the centralized heating, cooling, lighting, ventilation, and other systems that serve tenant floors as well as common areas in commercial and residential buildings. These systems consist of lots of different equipment, including fans, pumps, motors, dampers, chillers and heat pumps distributed throughout buildings to serve different spaces. Operators commonly set a static schedule for the entire system based upon the building's regular hours, which assumes that each day is the same and that each tenant floor is the same. This approach can result in unnecessary energy use; for example, a fixed-schedule cooling system might run at times when an office is empty, increasing utility costs and wasting energy.

Optimizing building energy systems could reduce GHG emissions by 0.03 annual tonnes per capita.

Currently, none of these groups has the tools to take smart, easy, cost-effective, and energy-efficient actions. While the challenges vary for each group, existing tools share a number of common limitations.

Existing building management systems typically struggle to coordinate (or integrate) every system in a building: one system might control lighting and another might control heating and cooling, making it difficult to use data to improve efficiencies across both systems. They typically have limited ability to incorporate external data streams, such as weather forecasts and utility prices that can help create energy-efficient operation schedules. Energy management overlays that pull data from the building's myriad systems to provoke operator insights using charts and graphs rarely deliver significant savings, because the information is incomplete and still requires the operator to study, interpret, and act upon it.

To address these challenges, Sidewalk Labs proposes to deploy a suite of energy "Schedulers" for building managers, office tenants, and residents.

As their name suggests, Schedulers would help schedule and manage systems, equipment, and appliances that impact energy use and GHG emissions. They would do so by integrating relevant data from building systems to improve coordination; incorporating external data sources, such as tenant temperature preferences, operating budgets, building occupancy, weather forecasts, and real-time energy prices; and making decisions to improve equipment control and scheduling consistent with monthly energy cost goals.

At the small neighbourhood scale of Quayside, Schedulers would help office tenants, residents, and building operators alike stay within their energy budgets, eliminate energy waste in unoccupied spaces, and help the neighbourhood meet its climate goals. At the full scale of the IDEA District, the power of this suite of Schedulers would grow with a significant amount of baseline information about energy patterns.

Sidewalk Labs estimates that, in addition to conserving energy, the Schedulers could reduce building energy costs — already low thanks to Passive House–inspired techniques — by roughly 20 percent when used in concert. Those savings occur due largely to reductions in waste from turning off equipment when not in use, from turning on equipment just prior to use, and from dynamically controlling set points for heating, cooling, and ventilation equipment to align with demand.

Applied within the IDEA District, Schedulers would enable already highly efficient, low-energy building designs to achieve their full potential — maintaining that low energy usage and reducing GHG emissions by an additional 0.03 annual tonnes per capita (or 0.5 percent) from the city's current average, on the path toward climate-positive. (These savings include those of the Perform tool described on Page 313.)

Consistent with Sidewalk Labs' belief in open digital services, Schedulers would be designed to integrate with the existing ecosystem of building control systems, including those made by leading Canadian companies in this area, such as Ecobee, Encycle, and SHIFT Energy. Consistent with its role as catalyst, Sidewalk Labs would aim to leverage or support existing capabilities that could achieve Scheduler objectives, and would only develop its own if the market has not already developed an adequate option.

Goal 1

Optimizing Building Energy Systems

Create automated "Schedulers" for offices, homes, and building operators

All proposed Schedulers would share a set of core features, designed to derive insights from a coherent stream of data on building- and neighbourhood-level infrastructure. These insights would build on several initiatives underway in the building controls industry, including the furthering of a standardized naming scheme, the incorporation of external factors, and a shift toward automation.

Standardized naming system.
Today's building data is not standardized or integrated across energy and other operational systems, making it difficult, and often impossible, to collect and analyze real-time information in one place. This isolation can make it difficult for a building management system to determine the most energy-efficient practices.

Take a hypothetical example: a company that leases space on the 19th floor of an office building wants to reduce energy use in its conference rooms by powering off video screens when the room is empty. To do this automatically, a system would need to coordinate information from the audio-video system, the lighting system, and the calendaring system. But since those systems tend to be operated by different vendors, standardizing or integrating this data would be prohibitively time-consuming, costly, and difficult to maintain over time.

Sidewalk Labs proposes to require buildings to adopt a standardized open-data naming scheme called "Brick" that would enable the Schedulers an unprecedented degree of coordination to help achieve building energy goals (see sidebar on Page 317).

Incorporating external factors.
Existing energy management tools for buildings typically cannot adjust their schedules based on external factors, because they lack both real-time access to external information and bi-way communication capabilities. Sidewalk Labs' Schedulers would be designed to consider a range of external factors, including building occupancy, weather forecasts, and energy prices, and to send direction to equipment.

Standardized building data would give Schedulers an unprecedented ability to coordinate energy systems and improve performance.

Automating for energy-efficiency.
Existing energy management tools often come with dashboards that present energy data in new ways and are intended to prompt action on the part of users. But even full-time building operators have little hope of making sense of the thousands of data points a commercial and multifamily building collects every minute and presents on a dashboard — let alone residents or office tenants who rarely wish to think about energy management.

Sidewalk Labs' Schedulers would have automated capabilities to optimize a far broader set of variables than tenants or operators can, establish new energy practices, respond more quickly to competing demands, and learn preferences over time.

For example, this type of automation could reduce air conditioning on a summer Friday afternoon when an office is closing early. Or it could open or close window treatments while adjusting the lighting levels to balance light and temperature on a sunny day. Or it could turn off the lights, turn down the air conditioning, and "hibernate" all of the screens and video conferencing equipment in a conference room when a central calendar shows no meeting scheduled.

In addition to these general properties, Schedulers have many features that respond to the unique concerns of a particular user group. These are described in the following pages.

Data Innovation

A digital "Brick" in the wall

Smart buildings must be able to recognize every last room, hallway, motion sensor, key fob reader, light bank, thermostat, and appliance inside them and to network them together.

Until recently, establishing such a system typically required massive coordination between the building's audio-video, lighting, and IT vendors to connect all these systems to a converged internal network — an expensive and time-consuming process. At best, some building subsystems can "talk" among themselves but not to each other, and never to other buildings.

Hence the development of Brick, a "metadata schema for buildings" created and tested in 2016 by research teams from seven universities or institutions (five American, two European).[18] Brick establishes a standardized naming scheme in which all devices are named by floor, room number, device type, and an index, so that TVs are identified as 19-301-TV-1, 19-302-TV-1, and so forth, while thermostats could be identified as 19-301-TSAT-1 and 19-302-TSAT-1. Such a naming schema allows a computer to understand which room a TV is in and how to control the lights and thermostat in that room to prepare for a presentation.

By using standardized labelling and classification, Brick can itself be automated, making the process far less time-consuming. Brick also allows developers to create applications that make building subsystems work together: suddenly, a building can learn to turn down the heat in a crowded mid-winter boardroom before the thermostat rises.

How Schedulers create more energy-efficient buildings

Building Schedulers would manage systems, equipment, and appliances that impact energy use by incorporating real-time data that includes external factors, such as weather, and building system information, such as occupancy levels.

External data sources

The Schedulers have insight into external data that can impact building energy use, including weather data (such as temperature, precipitation, sunlight, wind, and other forecasts) and electricity prices (which vary across the day with demand).

Weather data

Electricity grid pricing information

Building Schedulers

The Schedulers combine information from the external sources with insight into the operations of building systems to optimize energy consumption and reduce GHG emissions. The tools then communicate any changes needed back to building systems — for example, to adjust temperatures or control lighting.

Type 1
Office Scheduler

Type 2
Home Scheduler

Type 3
Building Operator
Scheduler

Automated commands are sent to building systems, optimizing energy use.

Building systems

Building systems track a variety of real-time metrics about energy use and communicate that information to the Schedulers, including data on occupancy, interior temperature, airflow, and electricity usage. The Schedulers can use this information to help the systems improve energy efficiency.

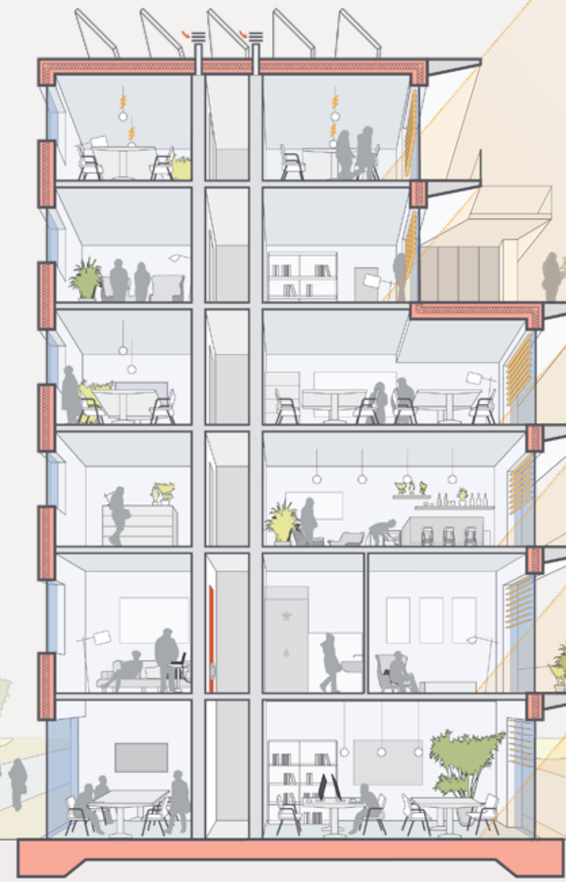
Lighting and occupancy sensors

Plug loads

Automated blinds

Ventilation

Heating and cooling systems with thermal comfort user feedback



Scheduler Type 1

Office Scheduler

The Office Scheduler is designed to manage energy use in offices, where no one is really in control of energy systems and thermostats and there are many competing demands.

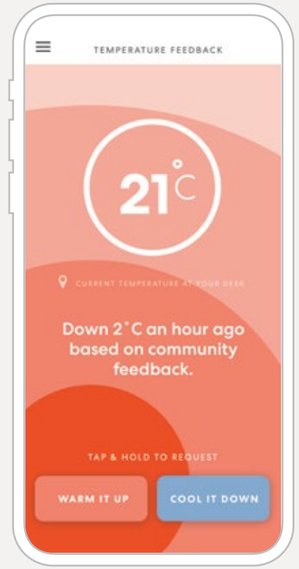
Commercial offices provide a great opportunity for energy savings. A study of commercial buildings in Toronto commissioned by Sidewalk Labs found that the 10 percent of office tenants with the highest energy consumption (on a per square basis) used about three times more than average, and the bottom 10 percent used only a third of the average. In other words, there is a wide range of energy consumption among commercial tenants, and a whole lot of waste at the top.

But today, no one is focused on saving energy in commercial tenant spaces. Existing energy management programs that could optimize thermostats and ventilation systems in commercial spaces are under the control of the building operator — not the tenant. The result is that spaces in many commercial buildings are operated based on default system schedules that do not match the tenant's needs.

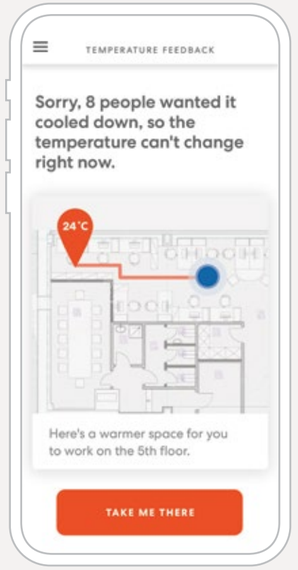
For example, an old lease provision might dictate that a cooling system run on Saturdays, because it was envisioned to be a working day by whichever lawyer drafted the lease, when in fact the office is always empty on weekends — incurring unnecessary costs for the tenant and wasting energy. It is rare for tenants to notice these operational hiccups, and even if they do, the process for updating a setting is complicated. Often it requires communication between office managers (who may not understand the implication of a change or feel empowered to make the decision) and building operators (who may feel similarly disempowered to override a lease).

The Office Scheduler would help tenants manage energy consumption and costs by optimizing all the systems under tenant control, based on factors such as energy prices. Some example capabilities of this tool could include:

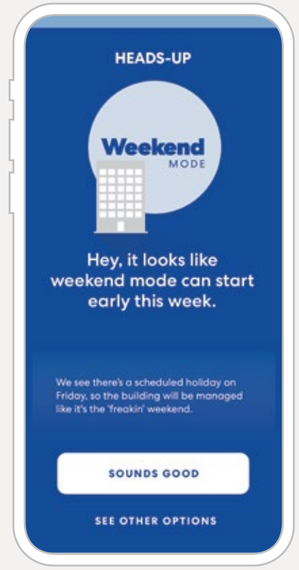
- Adjusting space temperature set points before, during, and after the day, based on insights such as weekly and daily occupancy trends, number of out-of-office calendar notifications, weather during the morning commute, and hot or cold requests throughout the day.
- Detecting what devices are plugged in and hibernating those that would not be needed for a while, based upon usage trends and occupancy.
- Starting up and shutting down heating, cooling, and ventilation devices based on factors such as how long the space takes to heat or cool relative to the outdoor temperature, when the first occupants are likely to arrive that day, and the desired thermostat setting.
- Responding to tenant hot and cold complaints with an explanation of the action taken, and, if no action can be taken because of competing requests from colleagues or system design limitations, identifying what area of the office might be more comfortable and whether there is a free desk or table there.



The Office Scheduler would be responsive to workers' needs, enabling them to provide feedback on things like the temperature of their space.



Tenants could get immediate feedback on a request that they make concerning the conditions in their space, and if their demand cannot be met, they could be guided to a new location where they may be more comfortable.



The Office Scheduler could keep facility managers updated about what is happening (and why) in a space while enabling them to override actions if necessary.

Scheduler Type 2

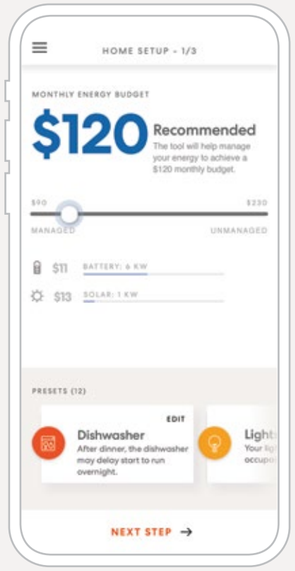
Home Scheduler

The Home Scheduler is designed to help homeowners manage their utility costs to suit their budgets.

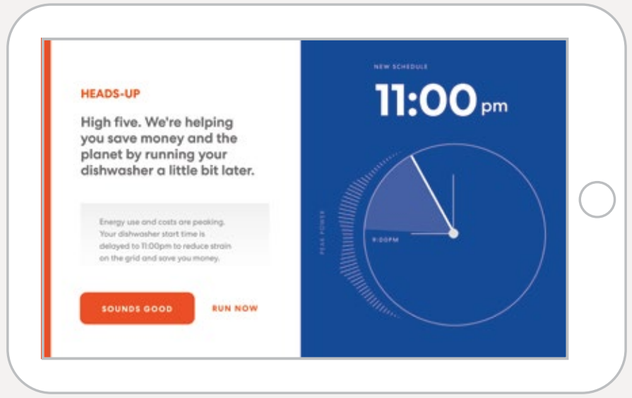
A typical smart home controller can do things like use motion detectors to know when a space is unoccupied and adjust interior temperature accordingly. The proposed Home Scheduler would go beyond these abilities to manage a full spectrum of household energy consumption. The tool could be tied into major appliances and devices that use the majority of the home's most expensive power. It also could have full visibility into the household's energy resources as well as real-time utility rates.

As a result, the Home Scheduler could take a proactive role in managing the home operating systems, devices, and appliances when costs are low or the grid is cleanest (which is usually the same time). The proposed tool would also generate a data feed for households to understand the actions being taken — and to override them, if they wish.

For example, a resident might load the dishwasher, press start, and walk away. Knowing the household's monthly utility budget, the Home Scheduler might automatically delay operation of the dishwasher for a few hours to avoid peak-time power pricing. In that case, the system would then inform the resident, who would have the option to reverse the decision and run the appliance anyway. Over time, the system could learn individual household preferences to reduce settings it recognizes as undesirable. (See Page 330 for more details on innovative bill structures and monthly energy budgets.)



The Home Scheduler would optimize systems to help households stay within their established monthly budget for energy costs.



Scheduler Type 3

Building Operator Scheduler

The Building Operator Scheduler is a tool specifically for building operators, designed to work in tandem with an existing building management system by adding all the automated features mentioned on Page 317.

These automated capabilities could free operators from their building management screens, which are cluttered with as many as 100 new system alarms each day — many of which are not urgent but are difficult to distinguish from the important ones. These alarms include notices such as "the outside air fan status has returned to normal."

One of the primary advantages of the Building Operator Scheduler would be its ability to automate ordinary tasks and distinguish real alarms that require the building operator's prompt attention from the numerous alarms that identify irregularities of no consequence. Rather than rigidly adhere to predefined rules, the Building Operator Scheduler would be programmed to learn by adopting beneficial actions from other buildings connected to the system as well as from the actions of other building operators in resolving similar alarms. As a result, many of today's current "alarms" could be screened and addressed before they are brought to the operator. Reducing the alarm load on operators would enable them to focus on things that require more personal attention, like doing preventive maintenance or addressing tenant complaints.

In addition to its broad access to base-building data, the Building Operator Scheduler would use energy more efficiently by soliciting information from the Office and Home Schedulers and would better predict and respond to the needs of tenants in a dynamic and real-time manner.

The broad ability to share building systems data across a neighbourhood of buildings could help communities benefit from operational best practices and lessons learned. This unprecedented degree of sharing could be transformational for the energy performance and operational efficiency of buildings and their staff as well as for the comfort of tenants.

All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the "Digital Innovation" chapter of Volume 2, on Page 374.

The proposed Building Operator Scheduler would provide a continuous feed of its actions to maintain transparency for building operators, but only important actions would be raised for an operator's attention.

Ch–4

Part 3

Making Full Electrification Affordable

Key Goals

1
Design an advanced power grid

2
Implement an innovative "monthly budget" bill target

Low-energy building designs and active energy management systems should help reduce energy demand and energy waste, but they would not eliminate the need for heating, cooling, and electricity. As mentioned at the start of this chapter, Sidewalk Labs' approach towards reducing GHG emissions and creating a climate-positive community involves going 100 percent electric and establishing a viable path towards creating a community that runs exclusively on carbon-free energy.

In Toronto, as in most cities, residents, workers, and visitors draw power from a main, centralized electricity grid. Strong public policy programs have helped Toronto and Ontario achieve very clean electricity generation that is 90 percent GHG-free.[19] At off-peak times (such as overnight), when few people and businesses are using electrical appliances, this grid can run primarily on clean energy sources, including nuclear, hydro, and renewables.

But at peak times, when electricity demand is high, this grid must use a greater portion of natural gas–generated power to meet the task, increasing the GHG intensity of the grid power supply as a whole. In addition to being the most expensive power to produce (in terms of marginal cost), natural gas–generated power also has 15 times the GHG intensity of the Ontario grid's current average,[20] so increasing its supply would increase both utility costs for households and businesses and GHG emissions for the community.

Adding to the challenge, the modern electricity grid faces new energy-hungry demands, including electric-vehicle charging and 24/7 access to digital streaming and computing power. To accommodate all these new uses, an electricity company typically would expand the size of its grid, which would increase utility bills as the company seeks to recover its investment.

To accommodate total electrification in the Sidewalk Toronto project area without increasing grid size relative to typical development, Sidewalk Labs plans to collaborate with Toronto Hydro (the public electrical utility) and technology providers to design an advanced power grid. This advanced power grid would go beyond a typical neighbourhood grid connection by integrating a novel "monthly budget" bill target, energy management tools, solar power, and battery storage to reduce the need to draw from the main grid at peak times.

Creating an advanced power grid could reduce GHG emissions by 0.05 annual tonnes per capita.

At the small neighbourhood scale of Quayside, the advanced power grid could help residents and tenants minimize their use of the grid's most expensive and GHG-intensive power and serve as a proof-of-concept for new utility rates and automated energy management tools. But as mentioned at the start of this chapter, such a system would require a greater scale of development to make economic sense and spread the cost of electric infrastructure among enough households and businesses to keep costs comparable to current utility bills.

Deployed at the full scale of the IDEA District, the advanced power grid could reduce GHG emissions 0.05 annual tonnes per capita (or 0.8 percent) from the city's current average, while maintaining comparable utility costs. These GHG benefits would be driven by an increased amount of space suitable for solar panels and batteries, specifically large open roofs on buildings in other development boundaries — as identified and volunteered for use by Waterfront Toronto — whose solar panels could feed into the system. Additionally, a greater share of buildings with automated energy systems would optimize loads and push non-urgent usage to off-peak hours.

At that scale, the advanced grid could also set a new paradigm for how utility companies manage and distribute local power, reducing the use of fossil fuels and the need to expand grid infrastructure while still keeping pace with substantial new electrification needs like vehicle charging, heating, and hot water.

Goal 1

Making Full
Electrification Affordable

Design an advanced power grid

Sidewalk Labs' proposed advanced power grid would consist of two connections to the main Toronto electricity grid supplemented by local solar generation and battery storage, as well as by backup biodiesel generators for emergencies. These local options could help the neighbourhood reduce its demand on the larger Toronto power grid, provide clean energy to buildings at periods of high demand, and provide protection against outages.

In recent months, Sidewalk Labs has worked closely with Toronto Hydro to explore potential designs for an advanced power grid with the following capabilities:

- The availability of community-sited solar and batteries that can be priced for customers to purchase shares each month based on supply and demand across the neighbourhood
- The ability to move power from the site on which it was generated or stored to another site with greater demand for it during a larger grid outage
- The ability to disconnect from the larger grid ("islanding") through switching and connections, so on-site energy resources could be fully used during a larger grid outage
- The ability to enhance grid reliability with distributed energy management visibility, control, and coordination into the neighbourhood (often called "behind the meter" insight) through a distributed energy resource management system
- The ability to use energy storage to handle peak usage in lieu of larger capacity (and more expensive) distribution infrastructure
- The ability to allow for greater quantities of intermittent renewable power generation to be installed or imported into the local distribution grid than typically permitted by utilities
- The ability to have a dynamic power rate to better incentivize and reward load shifting and conservation during peak times (see Page 330)

All of these provisions would contribute to the creation of a resilient and affordable all-electric neighbourhood.

An advanced power grid, featuring solar panels and battery storage, could set a new paradigm for locally managing and distributing electricity.

To help reach its energy targets on the path to climate positivity, Sidewalk Labs proposes that all new construction in the project zone be required to participate in this advanced power grid. Based on ongoing discussions, Sidewalk Labs expects that Toronto Hydro would (at a minimum) build and own the wires connecting Quayside to the main electricity grid. Sidewalk Labs plans to issue a request for proposals for a grid operator (which could be Toronto Hydro) to operate the distributed energy resources outlined below.

Solar.
In Quayside, Sidewalk Labs proposes that every tower have a photovoltaic array (solar panels) generating on-site renewable power, with an estimated 40 percent roof coverage. While solar power has extremely low GHG emissions, it is unpredictable: solar panels must receive sunlight to generate power. On a day that is hot and humid but also overcast, the solar panels may not be generating much power, nor would they be generating power after dark. They are also limited by the surface area on a tower.

The expected peak demand of Quayside would be a bit more than 5.4 megawatts. The roofs would support 747 kilowatts of photovoltaic, or solar energy equal to about 14 percent of the total load. At the proposed full scale of the IDEA District, solar energy could cover 19 percent of expected demand (101 megawatts).

Battery.
To help handle peak demands, the advanced power grid would use batteries to store power from the main Toronto grid during overnight hours, when it is relatively cheap and clean due to low demand. This battery power could be consumed during the hours of peak demand when natural gas–fired peaking plants are required and when power is generally the most expensive.

In Quayside, Sidewalk Labs plans to deploy a total of 4 megawatts of battery storage with 4 hours of capacity, totalling 16 megawatt hours of energy. Each battery would range in storage size from 0.25 to 1 megawatt; they would occupy in total 315 square metres of space in and around Quayside buildings. Altogether, the batteries would support about 74 percent of peak load in Quayside and the same share of peak load at the full scale of the IDEA District.

Backup power.
As a general rule, buildings that meet Passive House energy standards maintain habitable temperatures longer than conventional buildings without mechanical heating and cooling. If the main Toronto Hydro grid experiences a disruption, each building in Quayside could continue essential operations (such as domestic water pumping, toilet flushing, emergency lighting and limited cooling through fans) using biodiesel generation located at each building. Three days' worth of biodiesel would be stored on site and supplemental sources would be secured for refilling during an extended outage.

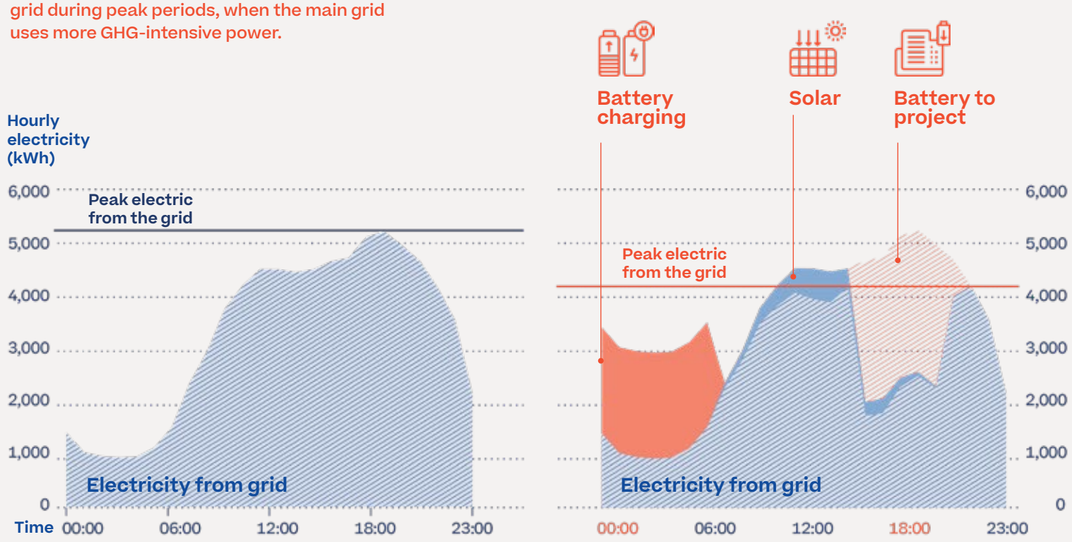
Grid flexibility and control.
To optimize the use of these community-sited energy resources, Sidewalk Labs plans to work with Toronto Hydro to develop and operate an innovative grid design that includes smart connections to solar arrays and batteries as well as switches. Switching would enable the community to be served by one or both of the Toronto Hydro grid connections; it would also enable the community, or portions of it, to disconnect from the main grid in the event of a broader power outage and share use of on-site solar and battery storage among buildings.

The distributed energy resource management system and other tools could allow the grid operator and Toronto Hydro to manage and control the community-sited energy resources and the thermal grid, and send price and other information signals to the building Schedulers to help manage overall community electricity demand, minimizing utility costs for customers and overall GHG emissions.

This approach to grid design and management could enable Toronto Hydro to integrate the operation of distributed energy resources like solar and batteries into its planning and management of the grid as a whole. These tools, together with the innovative utility bill described on Page 330, also would allow Sidewalk Labs and Toronto Hydro to build an advanced power grid that could be smaller than a typical grid — accommodating an all-electric development and changing electricity uses over time without enlarging grid infrastructure.

Reducing peak demand on Toronto's power grid

Solar energy and battery power would enable Quayside to rely less on Toronto's main power grid during peak periods, when the main grid uses more GHG-intensive power.



Without battery and solar, a development needs to draw heavily from the electricity grid during peak hours.

Batteries can be charged overnight, when power from the electricity grid is cleaner and cheaper. This stored energy, along with solar power, can be used to reduce demand on the grid during peak hours.

Goal 2

Making Full Electrification Affordable

Implement an innovative "monthly budget" bill target

To enable full electrification in an affordable manner, Sidewalk Labs plans to design an innovative customer bill structure that would give customers the chance to select their budget in advance — just like they do with mobile phone data plans. This bill structure would be designed around the following energy goals:

- Reducing GHG emissions that result from power use at peak times, when fossil fuel generators are operating
- Establishing transparency into rates and energy supply choices
- Creating predictable monthly power costs for customers
- Ensuring that residents who manage their energy can have bills equal or lower than business as usual
- Managing the demand for electricity to reduce the need for infrastructure expansion and to accommodate the electrification of vehicles and heating systems
- Offering customers the ability to own or lease the economic and environmental benefits of community-sited solar and battery

See the "IDEA District" chapter of Volume 3 for more details on Sidewalk Labs' proposal for a public entity (called the Waterfront Sustainability Association) to oversee rate structures for the advanced power grid.

Onboarding tenants and businesses. Sidewalk Labs proposes that when residents or businesses move into a building in the Sidewalk Toronto project area, an onboarding team could help them set their utility budgets based on their energy goals around cost and GHG emissions. This team would explain dynamic power rates as well as the other tools used to help manage monthly budgets: solar capacity, battery capacity, and the Scheduler management tools described on Page 314.

Implementing dynamic rates. In Quayside, Sidewalk Labs proposes that customers pay for electricity through a dynamic hourly rate that is based on the hourly price of electricity in the Ontario market. Costs would be appreciably higher at times of peak demand, when the grid needs natural gas–fired peaking plants, and prices would be much lower off-peak, when the grid has ample nuclear, hydro, and renewables generation to meet demand.

Existing "time-of-use" rates in Ontario are only an approximation of the true cost of generating electricity, since in reality, the price changes hourly in the market based upon the marginal cost of generation (meaning the cost to generate the last electron, based upon the generator that produced it). The goal of the dynamic rate in Quayside is to provide transparency and encourage actions to reduce electricity use during peak hours.

Managing monthly budgets. A combination of Scheduler automation and the availability of shares in the community's solar and battery capacity for purchase would enable residents and businesses to select their preferred monthly bill within a given scale. Selecting an amount at the lower end of the cost scale would result in a high level of intervention from the automated Scheduler tools, which would steer electricity use towards off-peak, low-cost periods in line with the monthly budget.

For example, a dishwasher turned on at 8 p.m. could automatically wait until 2 a.m. to run the wash, when power would be cheaper and cleaner. Customers would always be able to override the scheduler and pay more for utilities that month. Selecting a budget at the upper end of the cost scale would mean less Scheduler control.

The Schedulers could also recommend and facilitate the purchase of shares of the community-sited solar and battery capacity by customers who typically use electricity while the sun is shining or when the batteries would be discharged. Owning (or leasing) shares of these distributed energy resources would provide customers with the same economic and environmental benefits of having them in their home, reducing their use of peak time electricity.

All told, customers would have total control and visibility into their utility costs, choice of power generation sources and storage, and predictable monthly utility bills — without the headache of having to manage all of it.

Innovation case studies

The power of automation to reduce energy bills

In Ontario, since 2014, roughly 90 percent of the province's 4 million residential customers have been buying their energy through an option that includes a three-period time of use rate.[21] Such a rate structure encourages customers to shift energy use, as they are able, from peak times to off-peak times. Under this scheme, customers have reduced their peak demand by as much as 3 percent[22] as part of the province's electricity system transformation, which included reducing its need for fossil fuel–based generation and lowering GHG emissions and costs.

In recent years, a number of other North American utilities have piloted or rolled out similar time-varying power rates — some coupled with automated control tools such as smart thermostats. Studies of these programs have shown that the automation produces larger demand reductions by customers.

For example, in 2013, Baltimore Gas & Electric, a Maryland-based utility, began its Smart Energy Rewards program, which couples rebates for peak demand reductions with smart thermostats, opt-in utility-controlled air conditioner switches, smart appliances, and other energy management tools. Some 80 percent of customers have taken advantage of the rebates, reducing their energy demand by more than 16 percent and saving a combined total of $40 million USD on their utility bills.[23]

In Oklahoma, Oklahoma Gas & Electric initiated a variable peak pricing plan coupled with a smart thermostat. For the approximately 130,000 customers on variable peak pricing, the average peak load has dropped by approximately 40 percent and average bill savings have been as high as 20 percent.[24]

Sidewalk Labs anticipates that all energy needs would be served by the advanced power grid (and the thermal grid described in the next section). As a result, Quayside residents and businesses would not need gas accounts, which can average $30 to $150 a month depending on the season. Although electricity costs more than gas in Toronto, average customers should have utility bills comparable to those of households or businesses in a typical Toronto neighbourhood, with much cleaner energy consumption.

This proposed integrated power plan would cover the majority of commercial and household electricity costs, but not all of them. For example, electric vehicle charging could have a different pricing structure for residential and commercial customers to account for the parking space that the car is taking up while charging and to strongly discourage full charging at times of peak demand.

Residents and businesses would be able to set monthly energy budgets and receive clear utility bills that identify power sources and associated costs. (Bill shown here for illustrative purposes only.)

Resident Utility Bill

On Budget!
You have selected a budget of $150 Your total cost this month is **$143.91**

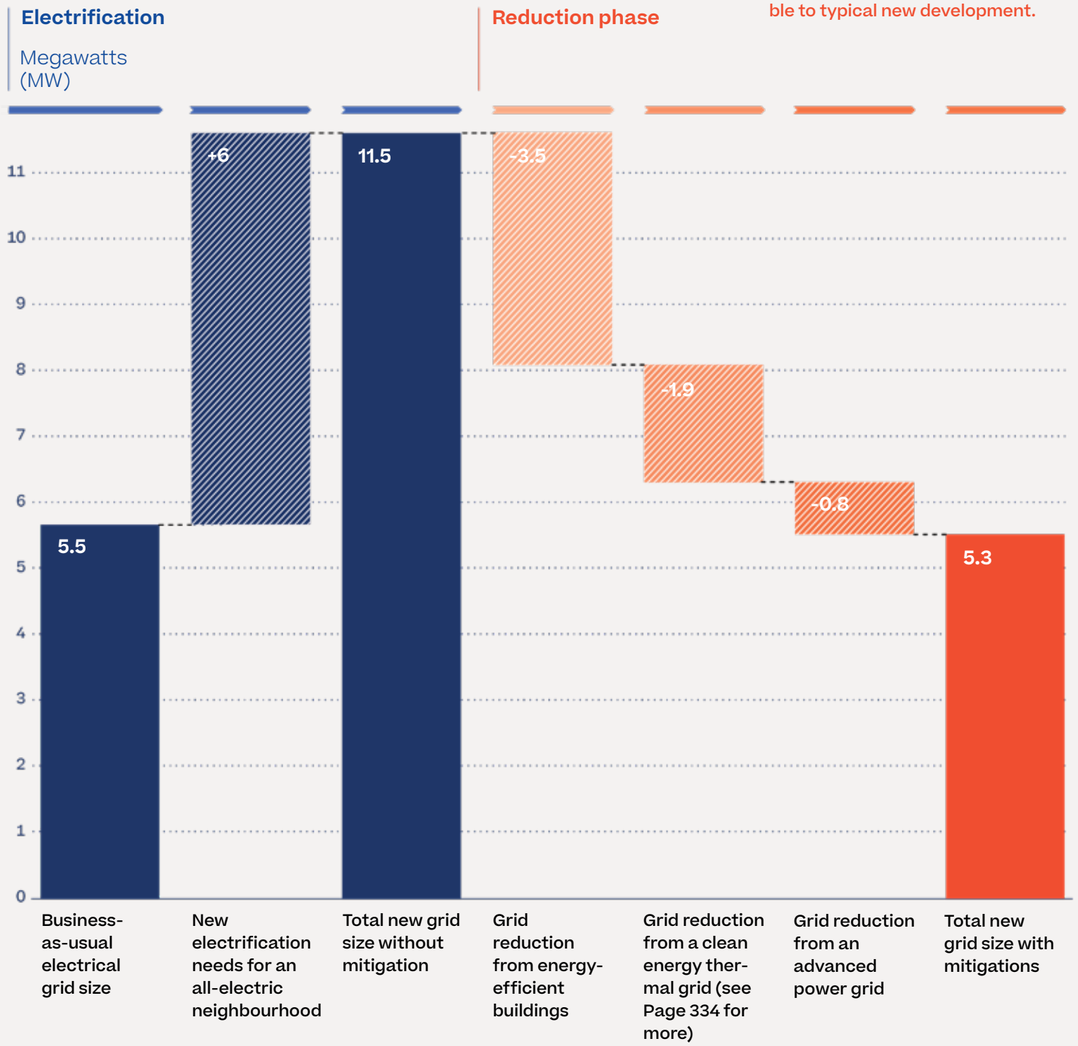
Electricity	$84.67
Thermal Energy Heating, cooling, and domestic hot water	$44.65
Community-sited Solar **0.23 kW** (**$13.17**/kw/month) Your solar shares avoided 1.4 kg of GHG emissions this month.	$3.03
Community-sited Battery **5.61 kW** (at **$1.87**/kw/month) Your battery shares avoided 1.9 kg of GHG emissions this month.	$10.48
Advanced Energy Grid Rebate **$3.44** savings was from your solar capacity **$41.59** savings was from you battery capacity	-$45.03
Thermal Grid Capacity Charge	$41.11

Amount due
$143.91

Achieving affordable electrification without a larger grid

A typical new development would require a power grid of 5.5 megawatts. An all-electric neighbourhood requires electrifying new things like vehicles and heat pumps. Unless mitigated, these additional uses would increase the size of the grid to 11.5 megawatts.

Sidewalk Labs proposes to mitigate the size of that grid while still serving these new electricity demands through efficient building envelopes, a thermal energy grid, and an advanced power grid. Together, these initiatives reduce the grid size necessary to serve the neighbourhood to 5.3 megawatts — comparable to typical new development.



Ch–4

Part 4

Using Clean Energy to Heat and Cool Buildings

Key Goals

1
Design a thermal grid to distribute clean energy

2
Capture building "waste" heat, geothermal energy, wastewater heat, and other clean energy source

A combination of low-energy buildings and active energy management systems would dramatically reduce the need for heating and cooling, but these efforts alone cannot eliminate that need, especially in a cold-weather climate like that of Toronto. Weather aside, neighbourhoods with a mix of residential and commercial spaces need heating and cooling year-round: residents take hot showers even on the hottest days, and many businesses with lots of computers or on-site fabrication and light manufacturing equipment run air conditioning even on the coldest days.

A handful of cities have long tried to meet some of their heating, cooling, and hot water needs more efficiently by using district-wide energy systems. Very early district energy systems, dating back to the 19th century, burned fossil fuels like coal to boil water in centralized plants to produce steam for heating buildings.[25] Today, a handful of innovative systems aim to tap clean energy sources; for example, Toronto itself uses water drawn from Lake Ontario to help cool about 60 buildings downtown.[26]

But even new district-energy systems face challenges at both the neighbourhood and building levels when trying to reduce or eliminate their reliance on fossil fuels.

Often the systems cannot access sufficient clean energy (in a financially viable manner) to meet peak heating and cooling demands, like in the dead of winter. District energy systems that use a central heat generation plant typically pipe their energy a long way to buildings and back to the plant again, leading to heat losses along the way. Traditional building construction requires substantial heating, which warrants high-temperature water, but high-temp systems cannot make use of available "low grade" (not very hot) clean heat sources, such as wastewater heat.[27]

To deliver heating and cooling to residents and businesses without using fossil fuels, Sidewalk Labs proposes to deploy a type of district energy system called a thermal grid, designed to help realize full electrification in an affordable way and to achieve a climate-positive community.

The proposed thermal grid provides buildings with clean sources of heat energy through a network of water pipes (or loops). Electric heat pumps can use heat energy from these loops to provide tenants with heating or domestic hot water, or the pumps can reject heat energy into these loops to provide cooling. The thermal grid is designed as a zero-fossil fuel system that relies on clean energy from a variety of sources, including geothermal (underground) energy, building waste (or excess) heat, and wastewater (sewage) heat.

The thermal grid has two core design features that help improve its efficiency. One is its distributed network of water-pipe loops at the building, site, and neighbourhood levels, which creates more flexibility in growing the system over time by adding new thermal energy sources. The other is its ambient (or low) temperature water loop, which reduces heat losses through the pipe network, thereby enabling the grid to rely on a wide variety of clean energy sources that might otherwise go untapped.

The thermal grid could reduce GHG emissions by 1.58 annual tonnes per capita.

When exploring the potential for such a thermal grid, Sidewalk Labs took scale into account from the start for three key reasons.

A thermal grid would deliver heating and cooling to residents and businesses without using fossil fuels.

First, such a system would be prohibitively expensive to create without scale, because a five-hectare neighbourhood provides limited opportunity to spread the cost of the upfront investment required to develop, operate, and maintain a large infrastructure system while keeping costs affordable to customers. Second, a thermal grid needs to be able to grow with development and serve new buildings and neighbourhoods as they are constructed and as new energy sources become available. And third, the full scale of the IDEA District creates the potential to tap into clean energy sources that can be exported to other parts of the city — thus fulfilling Waterfront Toronto's objectives for a climate-positive community.

Deployed across the proposed full scale of the IDEA District, the thermal grid could recover its costs across dozens of development sites and tap into multiple large energy resources in and adjacent to the IDEA District. This approach would reduce the community's GHG emissions by 1.58 annual tonnes per capita (or 25.1 percent) from the city's current average.

And if the thermal grid were to be extended to Ashbridges Bay Wastewater Treatment Plant on the eastern edge of the Port Lands, it could secure enough energy to export to existing (and planned) developments in the eastern waterfront, removing carbon from the environment in these areas. With 170 megawatts of energy potential, Ashbridges alone could heat up to 85,000 homes.[28]

Goal 1

Using Clean Energy
to Heat and Cool Buildings

Design a "thermal grid" to distribute clean energy

Canada is home to some of the most innovative district energy systems in the world, as exemplified by Toronto's deep lake cooling system. To build on this foundation while exploring a thermal grid concept, Sidewalk Labs paired the experience of Kerr Wood Leidal, a Vancouver-based district energy design firm, with the research excellence of Lawrence Berkeley National Laboratory, a U.S. national research lab. The goal was to provide Toronto with new heating and cooling approaches that could be pursued in developments across the city.

For Quayside, the initial design under serious study (although not yet finalized) is — in technical terms — a two-pipe, ambient-temperature, water-source system. In simpler terms, the thermal grid consists of a network of water pipes that circulate heat energy across the building, site, and neighbourhood levels. These pipe loops can transfer energy to one another through "heat exchangers," or devices that enable heat to cross into a new pipe without losing energy.

These separate loops provide several advantages over a single pipe network. They enable the thermal grid to conserve energy, by reducing the need to carry a single heat source long distances. They enable multiple buildings to exchange thermal energy, which is important in mixed-use developments that have simultaneous heating and cooling demands. And they enable the grid to tap a wider variety of clean energy sources across a greater geography.

Electric heat pumps in buildings can draw energy from a warm pipe or reject energy into a cool pipe as needed for space heating, space cooling, and domestic hot water. It is the heat pumps that provide the temperature control for the whole system — they are the "brains" of the thermal grid. Sidewalk Labs' initial designs include heat pumps at the site level (to provide appropriate space heating/cooling water temperatures and share energy between buildings) as well as at the building level (to raise the water temperature enough for domestic hot water).

The sections that follow describe the thermal grid's core infrastructure in greater detail.

Key Term

Heat exchanger

Devices that separate the thermal grid's building, site, and neighbourhood loops. Heat exchangers enable these loops to transfer heat energy, as needed, across metal plates.

Key Term

Heat pump

Electric devices that serve as primary means of controlling the temperature of hot and cold water loops in buildings.

Building loops would heat and cool residential and commercial spaces by circulating through radiant ceiling panels.

Building loop.

The proposed thermal grid would begin in the buildings, with each building having its own loops of hot and cold water. These building loops would heat and cool residential and commercial spaces by circulating conditioned water through radiant ceiling panels.

For domestic hot water uses that require even higher temperatures (60 degrees Celsius), such as showers, small electric heat pumps in the buildings would provide an extra boost. (Additional heat could be extracted from each building's sewage lines using these heat pumps.)

Site loop.

The thermal grid's second loop would exist at the site level to circulate hot and chilled water to multiple buildings, connecting into the individual building loops via heat exchangers. Heat pumps located at the site-level would get the water in the site loops to their desired temperature (around 45 degrees Celsius for the hot loop, and around 5 degrees for the chilled loop). During off-peak seasons, these temperatures could be adjusted to reduce heat losses and thus reduce the amount of work required by the heat pumps to reach the desired temperature.

Each site plant would use a geothermal field to exchange thermal energy with the ground. These geothermal fields would act much like big thermal batteries. On a cold day, the ground remains warmer than the outside air, enabling site-level heat pumps to draw thermal energy from wells in the fields; on a warm day, the ground is cooler than the outside air, enabling the pumps to deposit heat into the ground. The bedrock beneath Quayside has excellent thermal properties for geothermal heat exchange.

The buildings connected via the site loops could share energy as necessary. In many cases, the simultaneous heating and cooling needs across these buildings would be sufficient to meet energy demands.

Neighbourhood loop.

The thermal grid's neighbourhood loop would connect all of the site plants and allow for the transfer of energy among sites. For scenarios where site-level energy sources proved insufficient, the site heat pump plants could extract or deposit heat into the larger neighbourhood loop via heat exchangers. In some cases, one site would be depositing heat into the neighbourhood loop that another site could use.

The neighbourhood loop would transport heat from a variety of clean energy sources at an ambient temperature (a max of 32 degrees Celsius in cooling season and a minimum of 12 degrees in heating season). The neighbourhood loop also would connect the sites to other clean energy sources (such as industrial waste heat or data centres) and could tie into adjacent neighbourhood district energy systems, which may have complementary heating and cooling demands.

Finally, the neighbourhood loop would have a shared balancing plant to control the movement of heat through the neighbourhood. If the neighbourhood loop had more energy than any site needed — for example, in the peak of summer — the excess would be exhausted via a cooling tower. Connections for a roll-up temporary boiler would be available for emergency backup needs.

The system's two most innovative features are its distributed infrastructure and its ambient temperature loop.

Distributed infrastructure.

Some district energy systems heat or chill water in a single central plant before piping it back out to sites and buildings, requiring the water to travel long distances and thus causing it to lose some of its thermal energy prior to reaching the building. Further, if the building does not need the heat, the water is returned in a continuous loop, requiring more energy for pumping. Such a system must also be sized at the master planning stage, making it hard to expand with new development.

In Quayside, Sidewalk Labs plans for each site of buildings to have a mini plant tied into a geothermal field and for excess geothermal capacity to be shared among the sites through the neighbourhood's thermal grid. At a full scale of the IDEA District, the thermal grid could be expanded and tied into new site plants, other neighbourhoods, or additional heat sinks and sources like the Cherry Street sewage pumping station and waste heat from Enwave's deep lake cooling system.

Ambient temperature.

The other major advance of this design is its ability to go fossil fuel–free by using ambient temperature. This approach enables the system to leverage low-grade heat sources that would be considered too cool to be heat sources for a high-temperature hot water system.

In short, the idea behind ambient temperature water loops is to capture as many sources of heat as possible, and the idea behind the distributed system is to get these sources where they need to be with as little loss of energy as possible.

The flexibility of this system enables the grid design to change as the development materializes. For example, if Sidewalk Labs becomes able to tap into a new fossil fuel–free source of energy (or into neighbourhoods with complementary energy loads), it might reduce or eliminate the energy sources from the design that are very expensive, such as geothermal, without any impact on the greater system.

Integration with the advanced power grid.

To enable optimal energy and utility cost management, Sidewalk Labs proposes to combine the active energy management capabilities of the power and thermal grids, and to bill customers from a single utility.

This approach stands in contrast to the separation of gas and electric services that is the model in Toronto (and other cities) today. But it also recognizes that, in an all-electric development, thermal energy systems would become a major user of electricity and something that the grid operator (responsible for managing the neighbourhood's peak electrical demand) should be able to control and optimize in concert with other electrical loads. The thermal grid could even become a resource for generating and storing thermal energy when electricity costs are low and could be used later when electricity prices are high.

As is the case for its management of power, Sidewalk Labs plans to use the Office, Home, and Building Operator Schedulers to manage thermal energy consumption and costs for residents and businesses. The proposed Schedulers would play a critical role in allocating the cost of domestic hot water, heating, and cooling to customers. For example, in summer, a hot shower might effectively operate on "free" heat energy, by drawing on the heat rejected by air conditioning. But in winter, a hot shower might contribute to a peak-period heat demand that should account for the real-time cost to generate that heat. The intent of such pricing is to create transparency around the true cost of energy generation and delivery, which would change based upon the competing or complementary heating and cooling demands of other tenants in the neighbourhood.

Sidewalk Labs plans to issue a request for proposals to design and develop (or co-develop) the thermal grid and anticipates responses from leaders in the field, such as Enwave and Creative Energy, or an established utility in Toronto with a growing geothermal business, such as Enbridge.

Ongoing design exploration.

As part of its ongoing consideration into how best to achieve climate positivity, Sidewalk Labs plans to explore alternative thermal grid solutions to those proposed in the MIDP before selecting a final design. Specifically, Sidewalk Labs plans to evaluate alternatives in the hopes of finding systems with equivalent core performance while achieving even better performance in terms of embodied energy, ozone depletion, and lifecycle costs.

Goal 2

Using Clean Energy to Heat and Cool Buildings

Capture building "waste" heat, geothermal energy, wastewater heat, and other clean energy sources

To start, the proposed thermal grid would incorporate at least three primary types of clean energy sources: on-site and off-site building waste heat, on-site geothermal heat, and off-site wastewater heat recovery. The system would also be designed to accept off-site industrial waste heat (such as heat rejected by data centres, local manufacturing, and power generation plants) to help reduce costs.

Building waste heat (on-site and off-site).
Buildings generate all sorts of heat throughout the day. This heat comes from the equipment and appliances residents and tenants use, such as computers and television screens, as well as from hot showers.

Sidewalk Labs plans to capture and repurpose building waste heat to provide energy for heating and domestic hot water systems. For example, buildings would use heat recovered from their own wastewater systems to pre-heat domestic hot water, reducing the amount of energy needed by the building's heat pump to increase the temperature further.

At the full scale of the IDEA District, Sidewalk Labs estimates that, given its proposed mix of residential and commercial uses within buildings, 27 percent of the cooling and 31 percent of the heating would happen simultaneously.[29] This usage would enable waste heat captured from one space in a building (such as a server room) to be used to heat another space in the same site (such as an apartment), once transferred through the site's heat pump plant.

If the site has excess heat, it could be transferred to other sites to heat buildings or help generate domestic hot water. It could also be stored in the site's geothermal wells for use when it becomes colder. Finally, it could be exhausted through a shared neighbourhood cooling tower plant.

An off-site source of building waste heat could be available from the "chilled water return loop" operated by Enwave Energy Corporation, which provides hot and chilled water to many downtown Toronto buildings. Enwave has a sizable portion of customers who require air conditioning even during the winter, and the waste heat extracted by these buildings would be enough to meet the supplemental heating requirements of development in Villiers Island, if tapped for Sidewalk Labs' proposed thermal grid.

Geothermal (on-site).
In many ways, the earth is like a big underground battery that stores up energy. The ground is normally 10 degrees Celsius, which means it is warmer than a cold day but cooler than a hot day. Sidewalk Labs' proposed thermal grid would capture this geothermal energy via underground wells — sometimes called "geoexchange" — and use it to extract heat during the winter and store heat during the summer. Geothermal wells are good at providing heat on a cold day and extracting heat on a hot day.

The amount of building heating and cooling that could be supported by geothermal wells depends on the amount of available and suitable space located beneath buildings or in parks and open spaces. It also depends on the availability of significant upfront investment capital, as geothermal is high cost. In Quayside, Sidewalk Labs expects to serve most of the development's heating and cooling loads with 0.5 hectares of geothermal field space that would be located beneath the development parcels, as well as parts of Silo Park.

For all its benefits in a small neighbourhood like Quayside, geothermal energy is very expensive to harness, and therefore would not serve as a scalable clean energy source across a significant development area of the IDEA District. Geothermal energy could be used strategically in later phases of development, but as a secondary option to avoid fossil fuels.

Industrial waste heat (off-site).
Commercial and industrial processes can also generate enormous amounts of waste heat that have the potential to serve as yet another source of clean energy for a thermal grid. Sidewalk Labs has initiated explorations into accessing the waste heat of a data centre near Quayside, where computer servers generate considerable heat year-round. Another potential energy source is the Portlands Energy Centre, an electrical generating station near the Hearn in the lower Port Lands area.

Due to the flexible and expandable design of the proposed thermal grid, new sources of energy can be connected in as they become available.

Wastewater heat recovery (off-site).
All the wastewater flushed down dishwashers, shower drains, and toilets travels through sewers at just below 15 degrees Celsius in winter and 25 degrees in summer. As is the case with geothermal energy, this moderate temperature makes sewers good potential sources of heat on a cold day and good potential "sinks" of heat on a hot day.

Sidewalk Labs' proposed thermal grid could use this wastewater energy to help heat up or cool down buildings in an odour-free and sanitary way. As mentioned, wastewater within buildings could be recaptured to pre-heat domestic hot water. But Toronto's waterfront is home to broader sources of wastewater energy that could tie into the neighbourhood loop: the Cherry Street Sewage Pump Station and the Ashbridges Bay Wastewater Treatment Plant.

The Cherry Street Sewage Pump Station has the capacity to add pumping equipment for heat recovery purposes right at Lake Shore Boulevard and Cherry Street, near Keating Channel. The size and location of this pumping station would make it an excellent heat source and sink for a development expansion from Quayside further east along the waterfront.

Planning process

Why biomass is not an initial thermal grid source

Sidewalk Labs explored the use of biomass (such as wood pellets and solid waste) for its thermal grid, but ultimately determined it was not a good fit. Broadly speaking, the process of burning biomass fuel sources creates high-temperature heat that cannot be efficiently integrated with the low-temperature waste heat captured from Toronto's geothermal and sewer water sources. Individually, the sources of biomass each had challenges that offset their potential:

- Biosolids generally have a high ash and nitrogen content, which can create challenges in managing air emissions.
- Wood pellets are highly processed, which increases their GHG intensity and their environmental cost.[30]
- Existing natural gas demand that could be served instead with biogas well exceeds the potential for commercial biogas production, so biogas is not an ideal climate-positive solution for new development.

For all these reasons, Sidewalk Labs did not select biomass fuels as the preferred source of low-carbon heating.

Tapping wastewater energy to realize climate positivity.

Sidewalk Labs' proposed thermal grid could supply energy needs to Quayside and other parts of the IDEA District without the enormous supply of sewer heat that is available from the Ashbridges Bay Wastewater Treatment Plant, the second-largest secondary wastewater treatment plant in Canada, with a service population of roughly 1.5 million people. But this source is important to consider tapping for its potential to remove carbon from the environment in other parts of Toronto.

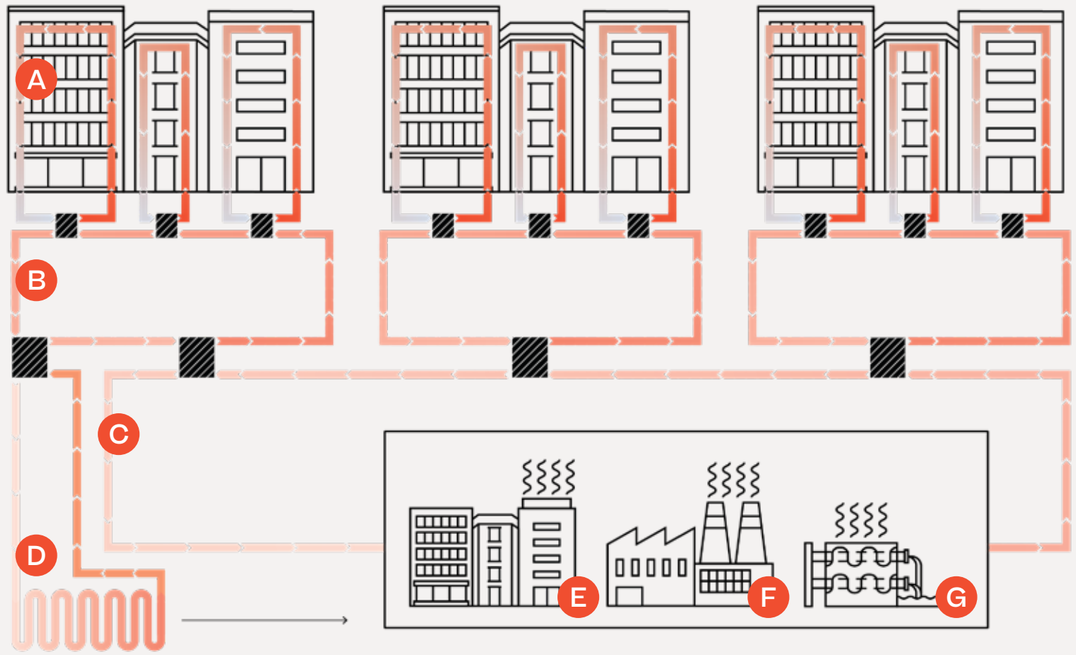
Located within 2 kilometres of the Port Lands, the Ashbridges Bay plant is in continuous operation, meaning it can provide a steady source of heat from treated (or "cleaned") sewage year-round. With an enormous 150 to 200 megawatts of thermal energy potential, Ashbridges alone contains enough thermal energy to heat some 35 Quaysides. At that scale, Ashbridges would be among the largest sewer heat recovery projects in the world.[31]

Tapping this source, with support of the city, would enable the Sidewalk Toronto project to go from meeting its energy needs to offering a clean source of energy to surrounding neighbourhoods, thereby achieving ts climate-positive ambitions.

Ashbridges would be among the largest sewer heat recovery projects in the world.

Explainer: How the thermal grid works

The thermal grid's flexible design uses three loops to exchange energy across a network of buildings and clean energy sources, including geothermal, building waste heat, industrial heat, and wastewater heat.



Distributed Infrastructure

- A Building loop
- B Site loop
- C Neighbourhood loop
- D Geothermal
- E Building waste heat
- F Industrial waste heat
- G Wastewater heat recovery

Ambient temperature

Heat exchanger

Note: Loop reverses direction in summer.

Ch–4

Part 5

Reducing Waste and Improving Recycling

Key Goals

1
Improve waste sorting through responsive digital signage

2
Implement "pay-as-you-throw" smart waste chutes

3
Reduce contamination during removal with vacuum tubes

4
Convert organic waste into clean energy

Reducing GHG emissions is not just about consuming less energy associated with heating, cooling, or electricity. It is also about wasting less and diverting recyclable (glass, metal plastic, paper, and cardboard) and organic (food) materials from landfills, where their decomposition has a significant climate impact. For example, food waste that ends up in a landfill produces methane, a GHG 25 times more potent than carbon dioxide.[32]

Toronto's 2016 solid waste management plan sets a citywide waste reduction target of diverting 70 percent of recyclables and organics from landfill waste by 2026.[33] But mid- and high-rise buildings along the waterfront and downtown have a long way to go to achieve those targets. Multifamily buildings currently divert only 27 percent,[34] and commercial buildings do even worse, at 13 to 19 percent.[35]

The biggest challenge to achieving that diversion rate is what waste experts call "source separation" — making sure that recyclables and organics go into separate containers from the very start and that they stay separated throughout the entire waste removal process. Source separation is essential to reduce the contamination that undermines recycling efforts; for example, paper cannot be recycled unless it is very clean.

Sidewalk Labs proposes to integrate a series of technological, policy, and infrastructure advances to exceed Toronto's goals for landfill diversion and to demonstrate an innovative path forward for neighbourhood waste. This plan would involve using digital signage to communicate proper sorting practices, deploying "smart" trash chutes in buildings to separate waste and allocate cost fairly by waste stream, and conveying waste to a centralized location through underground tubes to reduce contamination. Finally, this process would incorporate anaerobic digestion, a process in which organic waste is turned into a slurry and digested by microorganisms that dispel biogas, a form of clean energy.

In Quayside, this plan could build on the City of Toronto's long-term diversion rate of 70 percent and result in a landfill diversion rate of 80 percent. Some multi-family residences in Toronto have already achieved such rates through tenant education and operations. As an added benefit, this plan would dramatically reduce the amount of garbage truck traffic on neighbourhood streets by centralizing waste pick-up.

A smart disposal chain could reduce GHG emissions by 1.08 annual tonnes per capita.

Applied at the full scale of the IDEA District, Sidewalk Labs' approach to waste sorting could reduce GHG emissions by 1.08 annual tonnes per capita (or 17.1 percent) from the city's current average, largely thanks to anaerobic digestion, which controls the release of GHGs for beneficial use instead of emitting it into the atmosphere.[36]

Sidewalk Labs pilot

Using data to improve recycling habits

Much of the contamination of waste streams is believed to be the result of "wish cycling," in which customers assume that certain materials (such as a bio-plastic container or a coffee cup) are compostable or recyclable, when in fact they are not. These are not unreasonable assumptions, and they can only be corrected with direct feedback. But such feedback is difficult to provide to tenants in multifamily buildings.

Sidewalk Labs plans to conduct a pilot prior to any Quayside development to study how well building residents respond to feedback about their waste sorting behavior, with the goal of helping people recognize the complicated dos and don'ts of correct sorting, and ultimately improve their recycling practices.

For the proposed pilot, the trash, recycling, and organic waste streams of three multifamily buildings in Toronto would be collected by a hauler and brought to the Canada Fibers materials recovery facility. Canada Fibers conducts ongoing waste audits for Toronto, as a regular waste tracking service.

In a conventional waste audit, workers at a recovery facility perform a contamination analysis of waste by categorizing it by hand. For the pilot, the waste would be placed along a conveyor belt and classified by computer vision sensors trained to identify materials and contamination, developed by AMP Robotics.

Continued on Page 347

Goal 1

Reducing Waste
and Improving Recycling

Improve waste sorting through responsive digital signage

There is no way around it: recycling correctly is hard. Even the most environmentally-aware person has reasonable questions standing in front of several different waste bins:

"Should I put this bio-plastic container in the organics bin?" *(No, put in the trash. Anaerobic digester preprocessing facilities cannot discern between bio and polymer plastics, and the container will be presorted and sent to landfill.)*

"Do I really need to rinse this honey jar to recycle it?" *(Yes!)*

"Can I recycle this plastic garden hose?" *(Not in Toronto. Hoses often get caught in recycling machinery, occasionally leading to facility shutdowns.)*

To make matters yet more complicated, recycling rules often vary by municipality, neighbourhood, even home and office, meaning the right bin somewhere might not be the right bin somewhere else. And while many great online resources exist — including Toronto's Waste Wizard app, which tells building tenants which types of waste go where — office tenants have to seek out that information themselves.

Sidewalk Labs plans to tackle this challenge by meeting people right at the source of the problem — the building trash room — using dynamic signage to illustrate common sorting mistakes and explain their impact on waste-reduction goals. These digital signage campaigns could be informed by real-time waste characterization data communicated from a materials recovery facility (which sorts recyclable materials) or a recycling processor (which turns sorted recyclables into materials that can be resold).

The City of Toronto currently conducts ongoing waste audits to get a sense of current landfill diversion rates, but these audits are labour-intensive and expensive, and make up only a small sample of the city's overall waste practices. Sidewalk Labs proposes to automate these audits (sometimes called "waste characterization studies") using computer vision software developed by a company called AMP Robotics. (Sidewalk Labs is an investor in AMP.) Designed to be installed on waste conveyor belts in material recovery facilities, this software could classify waste and identify common recycling mistakes over time (see sidebar).

For example, the waste software might identify an increased rate of attempts to recycle to-go coffee cups, which are lined with polyethylenes that contaminate the recycling stream. This trend could then inform a digital signage campaign to encourage tenants to put these cups into the landfill trash chute — or better yet, to use a reusable cup! As an added bonus, this real-time understanding of waste trends could help the city work with manufacturers to reduce or redesign problematic products, an effort that is consistent with the 2016 Waste Free Ontario Act.[37]

Additionally, digital signage could inform building tenants about city waste programs such as trash donations, mobile drop-off deposits, and clothing collections. These signs could also be used to display the pending disposal of specialty items like old appliances or furniture that other residents of the building or the neighbourhood might want to take.

Continued from Page 345

Over the course of three months, signage showing the week's waste diversion percentage and most common recycling mistakes would be posted to provide residents with feedback on their recycling effectiveness, based on the building's aggregate waste practices.

Residents who volunteer to have their waste bags individually audited and analyzed would receive personalized feedback on recycling effectiveness, but in general, the feedback would be delivered at an aggregate building level.

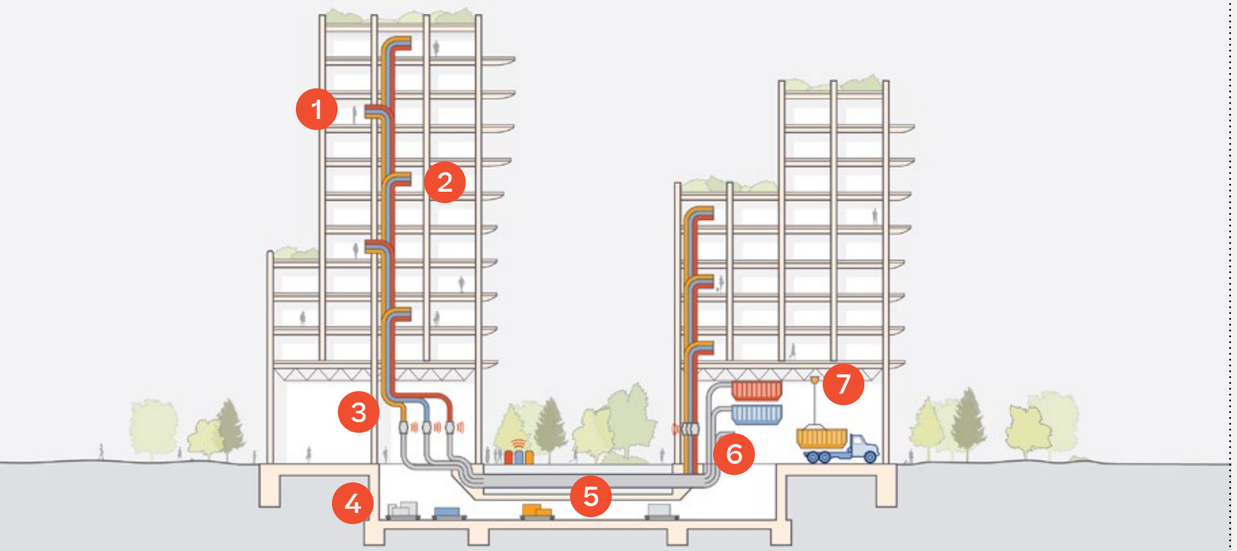
Additionally, the pilot would compare the waste analyses completed by workers at Canada Fibers with those from the computer visualization system to determine the effectiveness of such technology for ongoing waste characterization.

The pilot would conform to the same protocol used by the City of Toronto for its standard waste characterization studies, with the goal of ensuring that no waste could be identifiable to an individual. It would also follow Sidewalk Labs' proposed Responsible Data Use Guidelines, including by providing transparent signage about the program in participating buildings.

"Wish cycling" is a natural response from people who want to make their cities more sustainable. By helping residents recognize their recycling mistakes, this pilot can help create a real-time feedback loop in Quayside and beyond, making those wishes a reality.

Explainer: How the smart disposal chain works

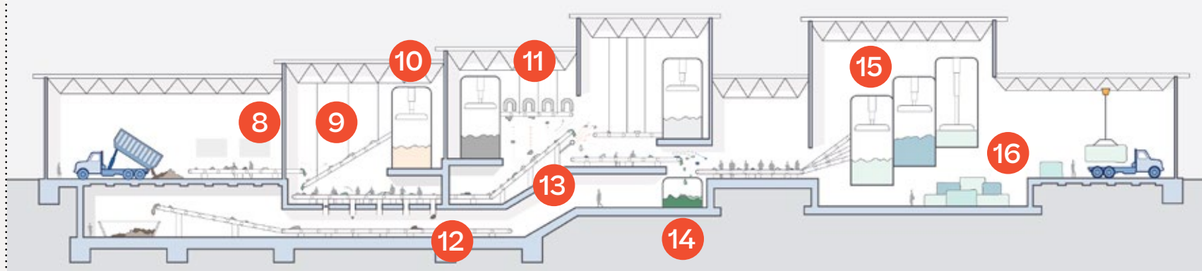
The proposed smart disposal chain begins with a set of three pneumatic waste chutes (one for landfill, recycling, and organic or food waste) that keep these streams separated, reducing contamination. These chutes transport the waste underground to an on-site neighbourhood collection point for truck removal.



The neighbourhood waste system helps to sort landfill, recycling, and organic waste.

1. Tenants unlock smart chutes to deposit their waste.
2. Three chutes (recycling, landfill, and organics) keep waste separate to reduce contamination.
3. A valve room manages the flow and release of material through the chutes.
4. Cardboard and oversized items that cannot go into the chutes are collected separately and transported via underground tunnels.
5. Pneumatic tubes transport waste underground.
6. Waste arrives at the neighbourhood collection point and is prepared for removal.
7. Crane systems load trucks with separated waste streams for off-site transport.

Trucks will transport recycling material to an off-site material recovery facility (MRF). The MRF helps to sort recyclable material further, separating out things like metal, plastic, and glass, as well as any remaining landfill waste. The resulting clean recyclable material then gets sold to manufacturers for reuse.



Recycling is processed at an off-site materials recovery facility.

8. A computer vision system categorizes data on recycling.
9. Screens and shakers further separate out small materials.
10. Powerful magnets pull metal items out of the recycling stream.
11. An eddy current (reverse magnet) pushes lighter-weight metals into a separate container.
12. Contaminants removed from the recycling streams are gathered for landfilling.
13. An optic eye conveyor is used to sort plastic types.
14. Heavy glass pieces remaining in the waste stream are sorted out via gravity.
15. Separated materials are compressed into bales.
16. The baled, recycled content is sent to market.

Goal 2

Reducing Waste
and Improving Recycling

Implement "pay-as-you-throw" smart waste chutes

All proposed digital innovations would require approval from the independent Urban Data Trust, described more in the "Digital Innovation" chapter of Volume 2, on Page 374.

Like many cities, Toronto has improved its recycling rates with "pay-as-you-throw" waste management program. These programs charge residents for the amount of landfill waste they throw away each week while collecting recycling for free. Residents who fail to sort their waste correctly risk having it left uncollected. In single-family homes and townhouses, pay-as-you-throw is credited with diverting 66 percent of waste in Toronto,[38] achieving similar success rates elsewhere.

Pay-as-you-throw programs have not translated effectively to multifamily buildings, for an obvious reason: unlike in a single-family home, where waste is set out in front of a specific residence, a building garbage chute or trash room has no way of knowing which tenant is throwing out what. To address this challenge, Sidewalk Labs has designed a building "smart chute" that could account for waste by building unit and bring pay-as-you-throw programs into dense urban neighbourhoods.

To adapt pay-as-you-throw for multi-residential settings, Sidewalk Labs proposes that buildings be required to provide three waste chutes consistent with City of Toronto requirements: organics (food), recyclables (glass, metal, plastic, and paper), and landfill garbage. These "smart chutes" could be unlocked from an app or a touch screen to verify a tenant.

Digital devices in the chutes would measure waste volume to charge tenants for what they deposited.

This approach differs slightly from the current municipal model; instead of no charge for recycling, there would be a lesser charge for recycling than for landfill waste to help avoid "wish cycling," wherein residents recycle things they should not, potentially contaminating the recycling stream. In suburban areas, such attempts would result in waste collectors leaving a bin behind; in a building waste room, the recycling charge helps keep people honest and encourage source separation. Creating more transparency into the cost of waste per person should also help reduce overall household waste — the ultimate goal.

The cost of the whole recycling system itself could also decrease with such an approach. Currently, the need to truck waste to a materials recovery facility for sorting adds 28 percent to processing costs. But by keeping the waste streams clean, this cost would decline, even as recycling increases.[39]

Cardboard (which can clog chutes) would be collected separately at no cost. Oversized or heavy waste that cannot fit into the chute would also be collected separately.

Toronto's pay-as-you-throw program has diverted 66 percent of waste in single-family homes. Sidewalk Labs plans to extend the program to multi-family buildings, with separate chutes for landfill, recycling, and organic or food waste.

For tenants, pay-as-you-throw costs would be commensurate with the actual cost of collection, transportation, and disposal of waste.

Enabling extended producer responsibility.

With enhanced capabilities for waste sorting and data collection, Sidewalk Labs can enable brand- or manufacturer-specific tracking of packaging and waste products and subsequently assign disposal costs accordingly, consistent with the direction of the 2016 Waste Free Ontario Act.

Initially, this data would be transparently shared with manufacturers, and could be used to "call out" issues with specific brands. For example, single-use coffee cups lined with polyethylene are known contaminants of the recycling stream. By tracking this brand-specific waste production data, Sidewalk Labs could help change packaging designs and hold major brands accountable. This approach is in line with the province's policy goals as well as the city's long-term strategy for creating a circular economy for waste.

Sidewalk Labs could also work with local retailers and restaurants to restrict the sale of materials that frequently contaminate the organics or recycling waste stream, such as plastic straws or black plastic coffee cup lids. Such efforts would not remove these products from the waste stream, but they could reduce contamination and offer a pilot district for City of Toronto Solid Waste Management Services to implement these restrictions more broadly.

Goal 3

Reducing Waste
and Improving Recycling

Reduce contamination during removal with vacuum tubes

Once waste leaves a building, there are still many places where "source separation" can break down before that waste reaches its final destination, potentially undermining landfill diversion efforts.

The standard approach of transferring waste by hand from tenant to buildings to garbage trucks creates the potential to contaminate recyclables and organics — not to mention introduce odours and vermin or taking up limited street or building space. Once recyclables arrive at material recovery facilities, "pickers" stand along conveyor belts and pluck out non-recyclable material, but they miss a lot due to the sheer volume of waste. And foreign objects in the organics and recyclables waste streams can even break the specialized machinery used to process these materials.

Sidewalk Labs proposes to deploy two innovations to help ensure that waste stays separated between the time it enters a trash-room chute and when it reaches an underground neighbourhood collection point: pneumatic waste collection and self-driving dollies.

1

Pneumatic waste collection.
Sidewalk Labs proposes to install an underground pneumatic tube system that would vacuum waste from the three building chutes (recyclables, trash, organics) to the neighbourhood's collection point. The pneumatic system would use pipes to send waste at up to 70 kilometres per hour.[40] Sidewalk Labs plans to issue a request for proposals to design the network and anticipates responses from leaders in the field, such as Envac, Transvac, and MariMatic.

See the "Mobility" chapter of Volume 2, on Page 22, for more on waste removal via the neighbourhood freight system.

2

Self-driving dollies.
Sidewalk Labs proposes to have self-driving delivery dollies transport items that cannot go through chutes or underground tubes from buildings to the collection point. These items could include oversized and specialty waste (such as paint), as well as cardboard and paper. Cardboard balers or shredders could be installed at a building level to minimize transportation required. Special building pick-up for disposal could be arranged and charged on an as needed basis.

In Quayside, the proposed collection point would be located on the edge of the neighbourhood. At the collection point, waste would be shifted into airtight containers (separated by the three types) for pick-up by city or private trash haulers. Recyclables would go to a material recovery facility; compacted landfill waste would go to a landfill; and organic waste would head to anaerobic digesters (see the next section for more details).

In addition to dramatically reducing waste contamination, this underground removal process could reduce the space needed for in-building trash storage and remove truck traffic from local streets.

An underground waste system would dramatically reduce the space needed for in-building trash storage, remove truck traffic from local streets, and create a cleaner waste stream for more effective recycling.

Goal 4

Reducing Waste
and Improving Recycling

Convert organic waste into clean energy

Toronto is already a leader in properly disposing of organic (food) waste, such as banana peels or half-eaten vegetables, to create a more sustainable city (see sidebar). As noted on Page 344, when placed in landfills, organics decompose to produce methane emissions, which have a significantly greater climate impact than carbon emissions. Additionally, if placed in recyclable streams, organics can render recyclables like paper non-recyclable.

But when separated out from the start, food waste can be converted into a clean energy source through a process called anaerobic digestion, which breaks down organic material biologically, just like a stomach breaks down food, creating biogas (or renewable fuel). After the fuel is extracted, the dehydrated material can be used for nutrient-rich compost (or soil amendments).[41]

Sidewalk Labs proposes a two-phase approach to handling organics. In Quayside, organic material separated at a building would travel through pneumatic tubes to the neighbourhood collection point. It would then leave this point and head to an off-site pre-processing facility to remove contamination and (at the same facility) be processed by anaerobic digesters.

At the proposed full scale of the IDEA District, with sufficient food waste to generate an investment return through conversion into fuel, it becomes economically feasible to explore neighbourhood-adjacent facilities capable of fully processing organics. In such a facility, the resulting biogas could be captured and exported to the natural gas grid that serves surrounding neighbourhoods. With an estimated 45,149 tonnes per year of source-separated organics disposed, the anaerobic digestion process would provide clean energy to supplement buildings outside of the IDEA District — thus helping the project fulfill its climate-positive mandate of exporting clean energy to other parts of the city.[42]

By creating biogas, the anaerobic digestion process could provide clean energy to buildings outside of the IDEA District, helping the project achieve climate positivity.

Best practice

Toronto: A leader in organics processing

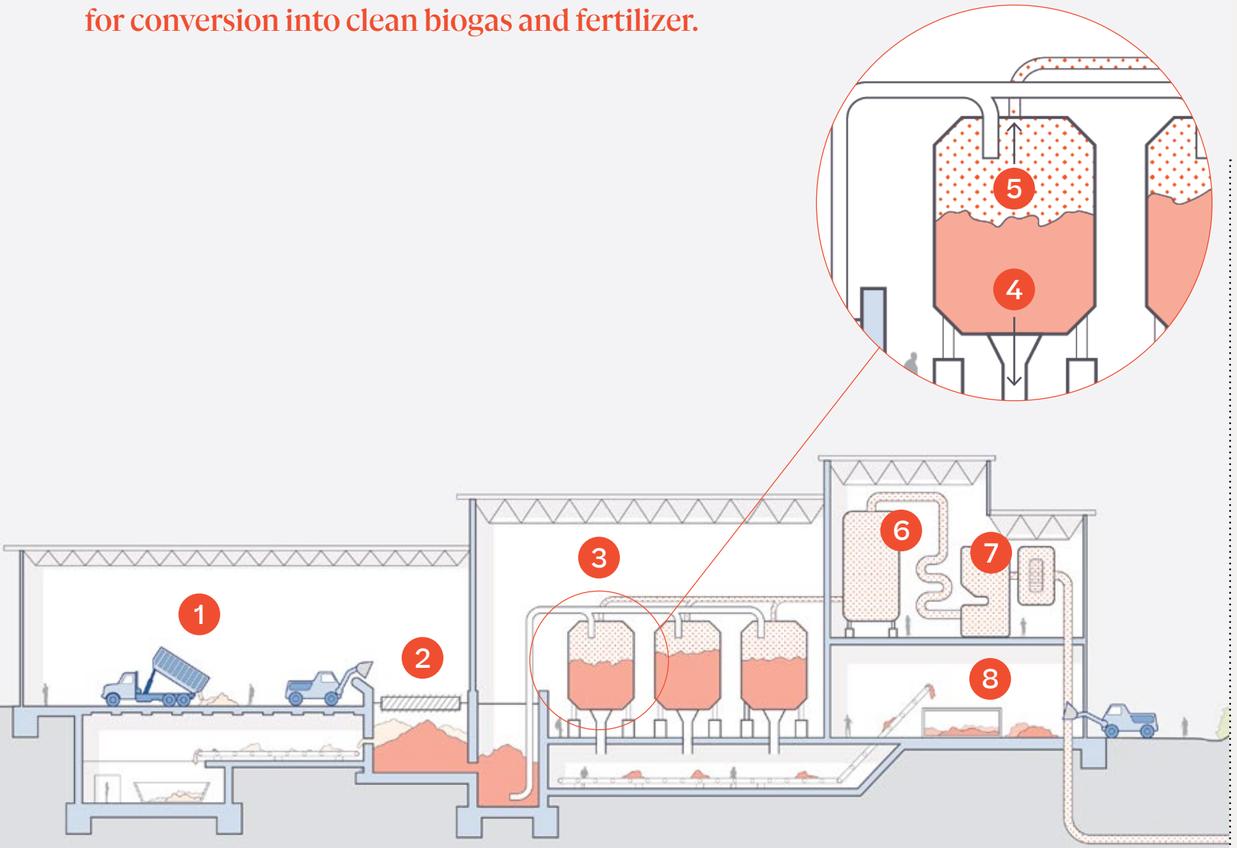
Built on a former landfill, Toronto's Disco Road Organics Processing Facility is a world leader in diverting food waste from landfill, using wet anaerobic digestion to process the city's organic waste. The end products of this anaerobic digestion process include compost, fertilizer, and flammable biogas (typically made up mostly of methane), which can be used as fuel for heating and cooking or compressed and used as vehicle fuel.

Organic material collected through Toronto's green bin program is shuttled daily to the Disco Road facility. After a round of pre-processing to remove plastics and other contaminants, the waste is blended into a pulp and fed to the system's anaerobic digesters, along with rainwater captured and collected on-site. After processing, the dried materials are shipped off for use in commercial compost while the liquids are treated in a wastewater facility. The biogas, meanwhile, is burned in an on-site boiler to keep the digesters operating at a steady temperature of 37 degrees Celsius.

A 24/7 operation, the Disco Road digesters process 75,000 tonnes of organic material each year, the equivalent of 2,800 truckloads.[43]

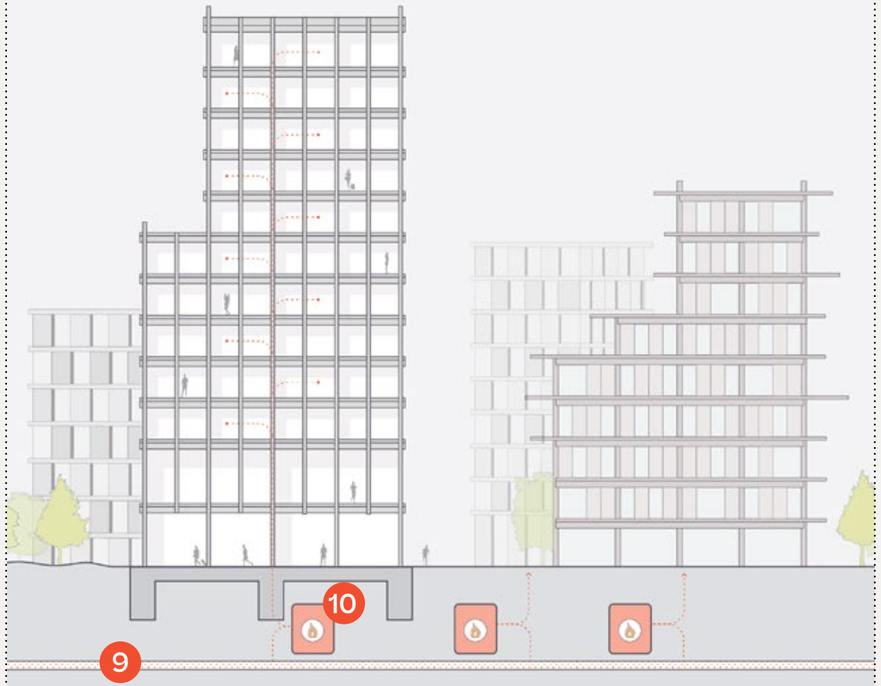
Explainer: How anaerobic digestion creates clean energy

In the proposed waste system, organic waste would get transported from the neighbourhood collection point to an anaerobic digestion facility for conversion into clean biogas and fertilizer.



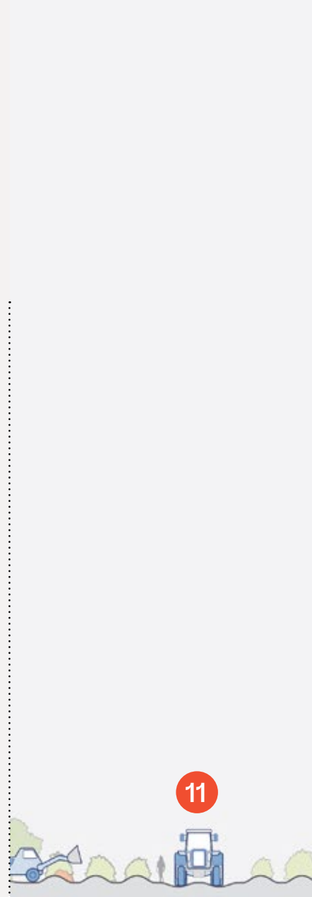
Clean biogas is created from organic waste.

1. Organics enter the facility.
2. Organics are macerated (or softened into a pulp).
3. Macerated organics enter digester tanks.
4. Nutrient-rich compost (fertilizer) is created.
5. Gas is created by the microorganisms.
6. Gas enters holding tanks.
7. Moisture and corrosive gases are removed.
8. Nutrient-rich fertilizer is sent to farms.



The Toronto energy pipeline could be supplemented by clean biogas.

9. Pipes carry biogas to off-site neighbourhoods via natural gas infrastructure.
10. Gas could be distributed in off-site buildings for heating and cooking.



Farm

11. Fertilizers are sent to local farms and markets.

Ch–4

Part 6

Managing Stormwater Naturally and Actively

Key Goals

1
Design green infrastructure into a neighbourhood

2
Monitor stormwater levels and quality with digital tools

No urban climate plan would be complete without a sustainable approach to managing stormwater. In recent decades, storms and rainfall have intensified around the world. Toronto has endured two 100-year storms in the past six years, including a 2013 flood that caused more than $850 million in property damage.[44]

Toronto has taken important steps to manage stormwater more effectively, given the potential of the city's combined sewer and stormwater infrastructure to contaminate Lake Ontario (whose drinking water serves 9 million people). Waterfront Toronto's groundbreaking $1.25 billion flood-mitigation program, announced in mid-2017, plans to renaturalize the Don River to help protect against stormwater overflows.[45] The city's Wet Weather Flow guidelines call for new development to reduce outflow of annual rainfall by 90 percent,[46] and the Toronto Green Standard's Tier 1 requirement calls for a minimum of 5 millimetres of stormwater retention.[47]

Building on these efforts can be as challenging as it is essential. Some cities invest in large treatment facilities to filter all stormwater for pollutants before sending it back out into rivers, streams, and lakes. This type of "hard" infrastructure is costly to implement and maintain; it also takes up valuable space that could be used for the public realm or other development uses. Meanwhile, standard practices for monitoring water quality occur manually, or not at all, and risk missing key outcomes.

To make matters tougher, most stormwater management plans occur on a parcel-by-parcel basis, leading urban landowners to build additional hard infrastructure (at great initial and ongoing expense) such as tanks and dual plumbing to meet stormwater regulations, rather to design for natural systems that require district-level planning.

The Sidewalk Toronto project presents an opportunity to think holistically about stormwater management and design *with* nature — rather than trying to control it.

Sidewalk Labs proposes to take a neighbourhood-level approach that integrates green infrastructure designs with digital monitoring tools to incorporate nature into stormwater management while minimizing the need for hard infrastructure. Green infrastructure (such as increased street and sidewalk plantings and green roofs) would help retain stormwater and purify it through natural means. Digital tools and an active control system could free up stormwater containers in advance of storms and monitor water quality in real time.

Active stormwater management could reduce GHG emissions by 0.01 annual tonnes per capita.

See the "Public Realm" chapter of Volume 2, on Page 118, for more details on the Open Space Alliance.

In a neighbourhood the size of Quayside, these practices would achieve Toronto Green Standard's Tier 3 for stormwater retention (25 millimetres). Sidewalk Labs estimates the system would reduce downstream energy costs by 50 percent (due to reduced pumping and UV filtration used in treatment facilities) and reduce stormwater moving into municipal systems by 90 percent (due to greater retention).[48] More broadly, this approach could create a public realm filled with green infrastructure that not only manages stormwater but provides secondary benefits to the community, such as increased tree canopy, landscape beautification, health qualities related to nature, and improved habitat for biodiversity and wildlife.

Deployed across the full scale of the IDEA District, these practices can help prepare the waterfront for a 100-year flood event and reduce GHG emissions by 0.01 annual tonnes per capita (or 0.2 percent) from the city's current average, thanks to expanded green space.

Sidewalk Labs proposes that a new entity called the Open Space Alliance operate and maintain the stormwater system. 

Goal 1

Managing Stormwater Naturally and Actively

Design green infrastructure into a neighbourhood

Green infrastructure encompasses an array of living systems that can include a wide variety of design components, such as green roofs, rain gardens, constructed wetlands, permeable pavement, and rainwater harvesting. Together, these systems can help regulate the flow of stormwater and naturally filter it for "total suspended solids" — particles that can pollute bodies of water.

They can also infuse nature in the public realm in ways that improve health and quality of life. Plants shade surfaces, reflect radiation, and release moisture to cool the urban environment, reducing the urban "heat island" effect. Natural landscapes have "biophilic" properties that can enhance well-being. And improved water quality can encourage people to reconnect with the waterfront.

See the "Buildings and Housing" chapter of Volume 2, on Page 202, for more details on biophilic design.

3,000 square metres

of heated pavement would reduce the need for street salting.

Sidewalk Labs plans to design a neighbourhood-level stormwater system that recognizes that water should be managed right where it falls — with no single point of failure. The features of this system include:

Improved bio-retention.

The highest retention requirement of the Toronto Green Standard calls for development to retain 25 millimetres of stormwater, meaning this amount is held back from the municipal treatment system and reused on site. To meet — or exceed — this standard, Sidewalk Labs plans to incorporate mixed open plantings and expanded soil volumes into its public realm (specifically, along its sidewalks), which would increase infiltration of stormwater into the ground as well as evaporation into the air.

Expanded tree canopy.

Sidewalk Labs plans to add soil volume in large beds along streets and sidewalks, as opposed to small tree pits, enabling the growth of root structures for a larger tree canopy, as well as the ability to include mixed plantings that promote biodiversity in flora and fauna. These soil cells also maximize the filtration potential for captured water.

Advanced soil remediation.

Sidewalk Labs plans to incorporate plants known to respond well to salinity (high salt volume in water). For example, poplar trees absorb bacteria and other contaminants, preventing them from flowing into the water — a process known as "phytoremediation."[49] Building on that insight, Sidewalk Labs plans to use principles for "inoculated phytoremediation," an approach to soil remediation that uses plantings known to remove toxins in the soil. Such practices have the potential to absorb total suspended solids up to 80 percent, dramatically reducing potential for water contamination.[50]

Permeable pavement.

The notion of pavement that effectively absorbs rain and melted snow has been around since the Roman Empire, which used stone pavers set in sand to allow for water to seep through the street.[51] Today, precast permeable concrete has gone from a niche technology to a more common one, in line with increased climate awareness and stormwater management needs. Sidewalk Labs plans to incorporate permeability into some of its modular pavers, enabling water to flow through them via pores into native soils or underground systems.

Sidewalk Labs also plans to deploy approximately 3,000 square metres of heated pavers in Quayside, reducing the need for street salting, which poses a threat to the environment (as well as to wheelchair accessibility). Since the 1980s, salt (chloride) rates in the mouth of the Don River have exceeded the Canadian Water Quality Guidelines threshold for long-term effects on aquatic health; in recent years, they have exceeded the threshold for short-term effects on aquatic health. From 2011 to 2015, the mouth of the Don had the highest 75th-percentile chloride concentration of all river mouths in Toronto since measurement began 50 years ago.[52]

Extensive blue and green roofs.

On top of its tower roofs, Sidewalk Labs plans to deploy "blue roofs" designed to store rainwater under photovoltaics as one means of retaining and detaining stormwater runoff. On podiums and terraces, Sidewalk Labs plans to deploy green roofs to absorb stormwater, as well as to reduce the urban heat island effect by insulating buildings.

Minimal cisterns.

Even this extensive amount of green infrastructure may not be enough to retain stormwater at times. For these cases, Sidewalk Labs plans to create a minimal number of underground cisterns to collect and store excess stormwater. These cisterns would be equipped with controls (more details in the next section) that can help re-use the water for site maintenance and irrigation, reducing the need for standard sprinkler systems.

Green infrastructure can naturally filter stormwater and infuse nature into the public realm in ways that improve health and quality of life.

Goal 2

Managing Stormwater Naturally and Actively

Monitor stormwater levels and quality with digital tools

To support its green infrastructure and minimal hard storage containers, Sidewalk Labs proposes to deploy an active management and monitoring system across all the aspects of the stormwater system that collect water, including cisterns, blue roofs, and pavement cells.

This system would consist of active valves designed to retain water for on-site use (such as irrigation) or empty containers in advance of a storm, as well as non-personal stormwater sensors designed to measure the quantity and monitor the quality of stormwater when it leaves the site.

At the scale of the IDEA District, this combined approach could save Toronto from building physical infrastructure to manage stormwater and prevent flooding, such as large conveyance systems and treatment facilities with large tanks and power-consuming filtration processes. This approach would also offer capital cost savings to building developers of up to 10 percent, because they would no longer need to install large, costly retention tanks and additional plumbing on their properties.

See the "Public Realm" chapter of Volume 2, on Page 118, for more details on preventative maintenance.

Managing stormwater capacity.
Stormwater sensors connected to management software can help neighbourhoods collect real-time data on things like stormwater levels, weather patterns, and water quality as well as manage stormwater infrastructure more actively.

For example, when stormwater software predicts heavy rains coming in a few days, volume meters on cisterns can make sure that valves in a stormwater system direct water to empty storage containers or into green spaces throughout the development, in preparation for the storm. All such storage containers would be connected to help the system coordinate stormwater response appropriately.

Additionally, stormwater management tools enable preventative maintenance by detecting potential leaks. They also enable an approach called "precision agriculture" that could monitor plant health and soil quality and determine when they need to be watered, using the water collected in the cisterns for these purposes rather than using potable water or over-watering via sprinklers.

Sidewalk Labs proposes to use software developed by OptiRTC, a leader in stormwater infrastructure controls, for its active stormwater system. (Sidewalk Labs is an investor in OptiRTC.)

Monitoring water quality.
Sidewalk Labs' proposed stormwater system incorporates water-quality monitors to help identify any anomalies and trigger more aggressive testing. In addition to detecting potential risks related to drinking water, ongoing monitoring could track measures that contribute to ecological health issues, such as salt runoff. These monitors would be located in the soil and on the outflow pipes that would connect to municipal systems, and could potentially tie into Ontario's broader existing water-quality sensor network.

Stormwater monitors could also help cities understand which water collections need treatment, rather than filtering all water by default — reducing the space needed for the treatment facilities while also saving energy. As a potential alternative to large-scale facilities that treat stormwater with ultraviolet exposure, Sidewalk Labs plans to explore the use of "in-pipe" ultraviolet treatment.

Ongoing exploration.
Beyond managing stormwater and waste within Quayside or the IDEA District, Sidewalk Labs is also exploring strategies to reduce source contamination and account for water and soil quality. For example, Sidewalk Labs plans to explore the potential to integrate new filtration or vacuuming technologies to reduce debris runoff from light rail tracks. Sidewalk Labs also plans to explore new policies that consider the overall environmental tradeoffs associated with contamination removal and take into account trucking of waste, among other factors.

Sidewalk Labs pilot

Using technology to improve green infrastructure

Sidewalk Labs aims to partner with the Natural Sciences and Engineering Research Council of Canada, University of Toronto, and Ryerson University on a stormwater pilot that would research the development, modelling, and maintenance of green infrastructure systems. The proposed pilot would use tools developed by OptiRTC.

Green roofs, for instance, are an increasingly common form of green infrastructure whose impacts have yet to be properly quantified. The pilot proposes to monitor measures such as water inflow, water outflow, and soil evaporation rates of green roofs to assess how they impact runoff volumes. The pilot would also use environmental (non-personal) sensors to assess the effectiveness of soil cells and permeable paving on stormwater retention.

Monitoring stormwater flow quantities could help planners and engineers appropriately size future stormwater retention basins to save both space and infrastructure costs. Meanwhile, monitoring stormwater quality could help manage green roofs and reduce the amount of ultraviolet light treatment used to clean the runoff headed to Lake Ontario. Ultimately, these systems could help create more adaptable and effective water treatment guidelines than the building codes in place today.

Explainer: How the active stormwater management system works

The proposed system reduces the need for large underground tanks and pipes by using green infrastructure (such as tree plantings and soil cells) as a first line of stormwater retention. Digital tools help handle excess stormwater by proactively emptying storage tanks before a storm; they also help reuse stormwater for irrigation and monitor water quality.

Water quality sensors test for contaminants and particulates.

Moisture sensors ensure proper watering for green roofs and soil cells.

Control valves allow retention tanks to empty in advance of a storm.

A An irrigation refuge ensures a fresh water supply in times of drought.

B Blue roofs store rainwater beneath photovoltaic arrays to manage the flow of runoff.

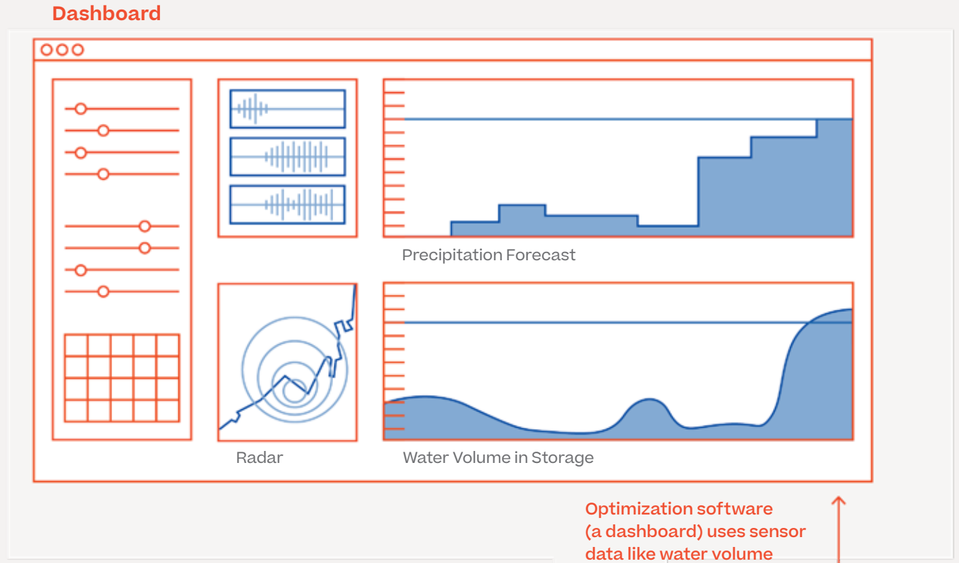
C Soil cells provide beds for trees and mixed plantings, which filter stormwater.

D Extensive plantings and green roofs promote more evaporation of stormwater.

E Retention tanks can store water for irrigation needs.

F Structural soil cells provide the space for more soil for roots beneath surface paving.

G A weather station can track precipitation, temperature, humidity, and solar radiation.



Ch–4

Public Engagement

The following summary describes feedback related to **sustainability**, and how Sidewalk Labs has responded in its proposed plans.

As part of its public engagement process, members of Sidewalk Labs' planning and innovation teams talked to thousands of Torontonians — including members of the public, expert advisors, civic organizations, and local leaders — about their thoughts, ideas, and needs across a number of topics.

1 Be ambitious with sustainability, in Quayside and beyond

What we heard

At each Sidewalk Toronto public engagement event, participants were passionate about the urgent need to address climate change and invest in cutting-edge, sustainable technologies and infrastructures. As one Residents Reference Panel participant explained: "If we continue at the pace we are going, it will be devastation for everyone. So you have to think about things like renewable energy, like the use of plastic, like prefabricated materials for building. We have to think about a lot of things for the future that we did not think about before."

Sidewalk Labs was especially encouraged with positive responses to its proposed sustainability priorities — particularly its goal to reduce per capita carbon emissions in Quayside by 85 percent and to achieve climate positivity within the IDEA District. Other areas of strong support included proposals for building performance, thermal energy infrastructure, and stormwater.

Participants of the sustainability breakout session at Public Roundtable 4 further validated Sidewalk Labs' ambition for the project to be carbon positive via thermal grids, clean electricity, and other sustainable technologies. Residents emphasized the importance of thinking at scale and ensuring that solutions were not just for one neighbourhood but could be replicated across neighbourhoods to have significant impact. They encouraged Sidewalk Labs to work with the province and existing Toronto-based companies to make this goal a reality.

Sidewalk Labs Director of Sustainability Charlotte Matthews addresses the Sidewalk Toronto Residents Reference Panel about the project's emerging sustainability plans. Credit: David Pike

How we responded

Thinking holistically.
Sidewalk Labs proposes a comprehensive package of innovations that together cut carbon emissions in Quayside to 0.9 tonnes of GHG a year per capita from the city's average of 6.3 tonnes (see Page 301).

Exploring scale.
The Sidewalk Toronto project can dip below the carbon-neutral line and into climate-positive territory by scaling its sustainability initiatives; Sidewalk Labs proposes implementation across a larger development area in the IDEA District to achieve this goal (see Page 302).

Investing in infrastructure.
Sidewalk Labs proposes to create a thermal grid that would draw energy from a variety of natural and waste heat sources, including geothermal and building wastewater, to provide affordable, fossil fuel–free heating and cooling (see Page 334).

2 Empower people to live more sustainably

What we heard

While recognizing that sustainable systems often require automation, participants encouraged Sidewalk Labs, whenever possible, to empower individuals to act more sustainably in their daily lives.

Participants were particularly excited by the role technology could play in raising awareness and gamifying positive environmental initiatives, such as dynamic signage or other kinds of "nudges" that could customize recycling feedback. Participants and experts also emphasized the need for jargon-free education, fee structures, and design.

As one Residents Reference Panel resident explained: "My condo building is only 10 years old, but it hasn't been designed to encourage energy conservation or recycling. … It's an additional hassle, and not a lot of people do it. But if you can design the building to make it easy to do, and even provide a tangible benefit like a rebate on condo fees, they'll do it. That's how people change."

Residents also emphasized the need for sustainable actions to be accessible to elderly residents and to be affordable, so as not to "hinder lower-income residents from practising sustainable behaviours." The Sidewalk Toronto Fellows went even further, encouraging the adoption of a system that would allow residents to visualize and manage local neighbourhood energy production and consumption.

Advancing electricity.
Sidewalk Labs proposes to create an advanced power grid that could provide an alternative source of clean electricity when the main Toronto Hydro power grid is at peak capacity (see Page 324).

Working with others.
Sidewalk Labs has been in discussions with governmental agencies (including the City of Toronto and the Ontario Ministry of Energy) and private companies throughout the creation and development of its sustainability plans, and would continue to collaborate with the private and public sectors.

Reducing waste.
Sidewalk Labs proposes to divert at least 80 percent of recyclable or compostable material from landfills (see Page 344).

Optimizing energy.
Sidewalk Labs proposes to deploy digital energy management systems that could help buildings operate in the most efficient way possible (see Page 316).

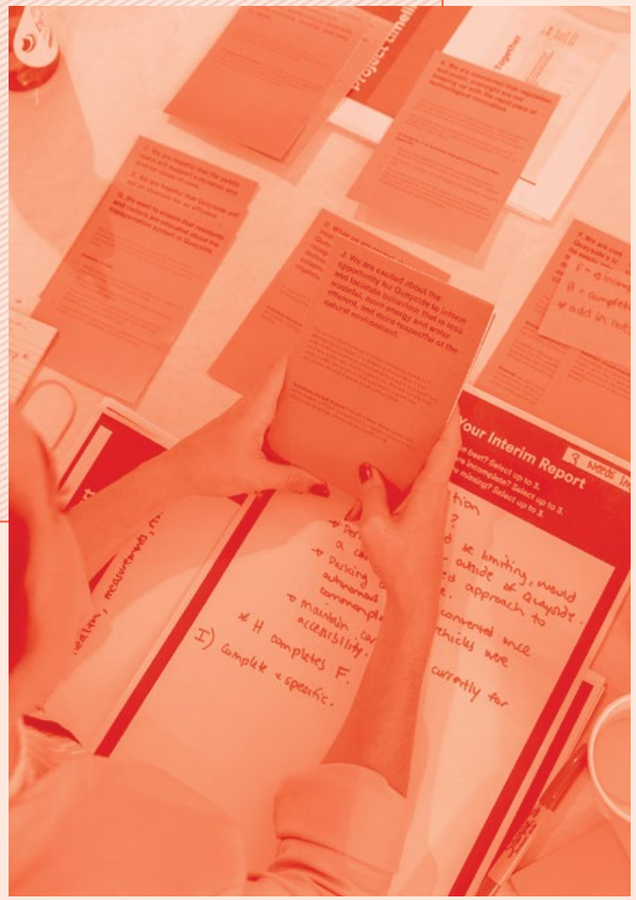
How we responded

Setting budgets.
Sidewalk Labs' proposed Home Scheduler would work within a household's monthly power budget to operate systems, devices, or appliances when costs are low and clean energy is available. The tool would also generate a data feed for homeowners to understand the actions being taken and to actively manage them, if they wish (see Page 330).

Encouraging accountability.
Sidewalk Labs proposes to implement a pay-as-you-throw model of waste that encourages households to reduce overall waste, as well as a modest recycling charge to help discourage "wish cycling" (see Page 350).

Informing decisions.
Sidewalk Labs proposes to run a recycling education pilot in multi-residential buildings in Toronto that are interested in helping residents improve sorting and recycling practices by using real-time feedback. This pilot partnership could help inform dynamic recycling signage in Quayside (see Page 345).

Maintaining affordability.
Sidewalk Labs supports a more distributed, resilient, and transparent economy underpinned by 100 percent renewable energy. The proposed advanced power and thermal grids would be designed to serve the community transparently and provide tools to make the right decisions around cost and carbon (see Page 324).



A Toronto resident considers the content of the Residents Reference Panel interim report, published in September 2018. Credit: David Pike

3 Be a steward of the environment

What we heard

The importance of environmental stewardship was a common theme at many public engagement events. Sidewalk Labs was urged by participants in the Indigenous Design Consultation to not only support the land and water ecology of the eastern waterfront but also to revitalize the plant life that originally thrived in the area. Members of the Sustainability Advisory Working Group also encouraged Sidewalk Labs to ensure sustainable forest management practices.

The Residents Reference Panel and participants at Public Roundtable 4 emphasized the need for climate change resiliency, particularly when it comes to creating functional, beautiful, and future-proofed stormwater infrastructure. The residents wanted to see an increase in focus on "softscaping" over "hardscaping." As one visitor to 307, Sidewalk Labs' Toronto headquarters, put it: "I see the waterfront as a unique and beautiful resource that should be primarily designated as parkland for the use of all Torontonians. I believe that as concerns about climate change rise, the importance of open green spaces, which can serve to mitigate extreme weather events like floods, will become ever more important."

How we responded

Integrating greenery.
Sidewalk Labs proposes a public realm in which parks act as green stormwater infrastructure, retaining and filtering stormwater through natural means (see Page 360).

Managing stormwater.
Sidewalk Labs proposes that green infrastructure would work in tandem with a digital management system that could, when needed, empty stormwater tanks or cisterns in advance of storms (see Page 362).

Planting native.
Sidewalk Labs plans for its plantings to be native wherever possible, with plant life chosen for its capacity for salt mitigation, resilience, evapotranspiration rates, and biodiversity (see Page 360).

Ensuring resiliency.
Sidewalk Labs plans to meet and surpass the City of Toronto's resiliency framework for flood management, as well as for and building services when power is lost.

Engagement spotlight

In early 2018, the sustainability team at Sidewalk Labs was brainstorming ways to help Toronto divert as much waste from landfills as possible. One big challenge the team identified is that even when consumers want to recycle, they often struggle to recycle correctly because they do not know what goes where. The team had an idea: What if people could just throw everything in one place, and robots in a waste or recycling plant could take care of the rest?

When the team presented this idea to the Sustainability Advisory Working Group, the group cautioned against the tactic for two reasons. The first had to do with contamination at the source: no robot can stop an open can of soup from contaminating and destroying what was once perfectly recyclable newspaper. The second reason was that the City of Toronto's entire system is designed to encourage consumers to separate materials; if one neighbourhood were different, it could confuse consumers and jeopardize the real progress being made, invalidating much of the time, energy, and resources the city and other non-profit organizations had expended in educating the public.

The Sidewalk Labs sustainability team went back to the drawing board and decided to ask a different question: How could technology help people to recycle correctly? Taking inspiration from the city's Waste Wizard app, the team developed a real-time feedback concept for multi-residential buildings that could let communities know how effectively they are sorting, empowering them to recycle better.

Visitors discuss conceptual visualizations of Quayside in the main hall of 307. Credit: David Pike

Acknowledgements

Sidewalk Labs would like to extend special thanks to the participants of the Sidewalk Toronto Sustainability Advisory Working Group, and to the staffs of the City of Toronto, Province of Ontario, and Government of Canada for their time and guidance.

Endnotes

General note: Unless otherwise noted, all calculations that refer to the full proposed IDEA District scale are inclusive of the entirety of its proposed geography, including all currently privately held parcels (such as Keating West). Unless otherwise noted, all currency figures are in Canadian dollars.

Charts note: Sources for the charts and figures in this chapter can be found in the accompanying copy for a given section; otherwise, the numbers reflect a Sidewalk Labs internal analysis. Additional information can be found in the MIDP Technical Appendix documents, available at www.sidewalktoronto.ca/midp-appendix.

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Chapter 5

Digital Innovation

Ch–5

Introduction

The Vision

Catalyze digital innovations that help **tackle urban challenges** and **establish a new standard** for the **responsible collection** and use of data in cities.

The ability to create the conditions for digital innovation is at the heart of Sidewalk Labs' vision for the city of the future. Digital innovation is the basis for many of the core planning initiatives that Sidewalk Labs has proposed throughout this Master Innovation and Development Plan to improve mobility, affordability, sustainability, and economic opportunity. It is also essential for catalyzing an ecosystem of new services and solutions by individuals, Canadian companies, local Toronto entrepreneurs, and other third parties from around the world.

That ecosystem is thriving in Toronto. Today, digital innovation is powering the region, from the cybersecurity and software startups in the Toronto-Waterloo corridor to local institutions like MaRS Discovery District, Communitech, the Vector Institute for Artificial Intelligence, and Civic Tech Toronto. Together these forces are driving Toronto's future: in 2015, the digital economy generated $117 billion nationwide,[1] supported 4,000 new Toronto businesses,[2] and provided 400,000 jobs for the city.[3]

But digital innovation raises a number of challenges that cities like Toronto are just starting to address. These include making sure basic digital infrastructure is affordable and open to everyone, making sure data is standardized and publicly accessible, and making sure there is a transparent process for protecting privacy and the good of the city.

These challenges are especially complicated for "urban data," which Sidewalk Labs defines as information gathered in the city's physical environment, including the public realm, publicly accessible spaces, and even some private buildings. While Canada has a strong foundation of privacy laws around personal information, and recognizes privacy as a fundamental human right, urban data creates a new set of questions that have surfaced during the Sidewalk Toronto public consultation process.

How can both cities and companies use data in a responsible way in the digital age?

How should the collection of data in public spaces evolve to match the speed of today's digital devices and the rapid development of artificial intelligence?

How can cities continue to engage in a meaningful public dialogue that addresses valid concerns about the impact on personal privacy, or about using urban data for the greater good?

Toronto and Ontario have taken some important initial strides to advance the conversation around data governance principles, including calling for public consultations to discuss how the digital economy can support business while protecting privacy. But while every city faces new barriers in the digital age, no place has yet adopted a comprehensive approach to address these challenges and create the conditions for digital innovation to flourish responsibly. The Sidewalk Toronto project presents a unique opportunity to do just that, and Sidewalk Labs proposes a holistic approach to digital innovation with four core components.

Key Term

Urban data

refers to information gathered in the city's public realm, its publicly accessible spaces, and even some private buildings.

The innovation plan.

First, Sidewalk Labs proposes to establish open digital infrastructure that provides a shared foundation for using urban data to improve quality of life. This core infrastructure would be anchored by ubiquitous, affordable internet connectivity within the IDEA District, consistent with Waterfront Toronto's aspirations for closing the digital divide. It would also include physical mounts that can significantly reduce the cost of launching new digital innovations and help ensure that cities do not get locked into using proprietary solutions.

Second, Sidewalk Labs proposes to outline clear standards that make data publicly accessible, secure, and resilient. Today's urban data tends to be scattered across many owners, outdated, or

stored in messy file formats, making it difficult for the community to use as a foundation for new ideas. Clear standards would make (properly protected) urban data accessible to researchers and the community in real time, and make it easy for third parties to build new services or competitive alternatives to existing ones.

Third, Sidewalk Labs proposes a trusted process for responsible data use that would apply to all parties (including Sidewalk Labs). This process would be anchored by a Responsible Data Use (RDU) Assessment — an in-depth review that is triggered by any proposal to collect or use urban data — and guided by a set of RDU Guidelines that incorporates globally recognized Privacy by Design principles. The process, including approvals, would be overseen by an independent Urban Data Trust created to be a steward of urban data and the public interest without stifling innovation.

Finally, Sidewalk Labs proposes to launch a minimal set of digital services that would catalyze this ecosystem of urban innovation. These services and applications — all of which would be open to competition and subject to the proposed responsible data use process — represent innovations currently not being pursued by the market but that remain essential to achieving Waterfront Toronto's quality-of-life objectives. Furthermore, the (properly protected) urban data generated by these launch services would be made publicly accessible (on a non-discriminatory basis), enabling companies, community members, and other third parties to use it as a foundation to build new tools.

Benefits of implementing the vision

- Pilot new digital services that improve quality of life
- Build fast, affordable digital infrastructure for residents and workers
- Help make Toronto a global urban innovation hub
- Establish a new standard for responsible data use

The impact.

At the small neighbourhood scale of Quayside, Sidewalk Labs' proposed approach would help pilot a range of services that improve daily life for neighbourhood residents, workers, and visitors across its core innovation pillars. These include a mobility management system that could use travel data to improve congestion and safety; an outdoor-comfort system that could use weather data to make the public realm more usable; a building-code system that could use structural and noise data to support a mix of residential and commercial uses; and energy management tools that could use data on energy demand and pricing to reduce peak-hour use, and thus greenhouse gas emissions.

Applied at the full scale of the IDEA District, the conditions of urban data, digital infrastructure, and core services would catalyze a new ecosystem for urban innovation, filled with technological advances by others that make urban challenges easier to tackle. That might include anything from a next-generation bike-share service, to small business tools that help retailers launch a successful pop-up, to civic tools that help families find an affordable home, to improved building designs that reduce energy use, to new apps that bring people together outdoors. The list would be bound only by imagination.

Sidewalk Labs' proposals for digital innovation would make it possible for the IDEA District to achieve key quality-of-life objectives. It would also serve as the cornerstone of a new global hub for urban innovation, estimated by Sidewalk Labs to generate $14.2 billion in annual economic activity and give rise to 93,000 total jobs, including nearly 10,500 jobs focused on urban innovation — attracting entrepreneurs from all over to the IDEA District.[4]

Above all, Sidewalk Labs' approach aims to demonstrate to Toronto, Ontario, Canada, and the rest of the world that cities do not need to sacrifice their values of inclusion and privacy for economic opportunity in the digital age.

IDEA District

The 77-hectare Innovative Design and Economic Acceleration (IDEA) District, consisting of Quayside and the River District, provides sufficient geographic scale for innovations to maximize quality-of-life impact and to become financially viable.

In Focus

Sidewalk Labs' role in creating the core conditions for digital innovation

Sidewalk Labs proposes to establish a set of core conditions that would catalyze an ecosystem of urban innovation along Toronto's eastern waterfront, consistent with Waterfront Toronto's objectives of improving quality of life and creating new economic opportunities in the digital age. These conditions include shared digital infrastructure, an open and secure approach to architecture and standards, a catalyzing set of digital services, and a trusted process for responsible data use.

As the diagram on this page shows, the role that Sidewalk Labs proposes to play would vary across these conditions and would follow a general approach of enabling innovation by others.

Responsible data use

Existing Canadian privacy laws

PIPEDA
Personal Information Protection and Electronic Documents Act

MFIPPA
Municipal Freedom of Information and Protection of Privacy Act

FIPPA
Freedom of Information and Protection of Privacy Act (Ontario)

Urban Data Trust

Responsible Data Use Guidelines and Assessments

Monitoring and enforcement

Digital services

Services and applications	Data sharing	Application-specific hardware
Limited set of Sidewalk Labs launch services	Open data portals	Sustainability
Countless other services and applications	Open City Network	Mobility
	Other data sharing programs	Public Realm
		Buildings
		Other hardware

Digital infrastructure

Privacy	Connectivity	Hardware
Digital credentials	Ubiquitous Wi-Fi	Standardized mounts
Other privacy infrastructure	5G providers	Super-Passive Optical Network
	Other wireless networks	
	Software Defined Network	

Open and secure standards

Physical standards
Data format standards
Security and resilience standards
Protocol standards

Key

- Sidewalk Labs participation
- Some Sidewalk Labs participation but primarily third-party involvement
- Third parties play a leading role

General approach: Buy rather than build, wherever possible.
In keeping with its role as catalyst in the Sidewalk Toronto project, Sidewalk Labs prefers to purchase third-party technology — or partner with third parties to create (or enhance) it — whenever there are existing companies that have the capability and incentives to implement the systems required. Sidewalk Labs plans to give priority to technology that is local to Toronto, Ontario, or Canada.

In cases where technology does not currently exist, and where entrepreneurs or established companies are not building them, Sidewalk Labs plans to build the technology. These are likely to be cases that require significant up-front investment the market is not currently making, or where success focuses on longer-term objectives that other companies are designed to pursue.

In all cases, other entities would be free to develop and provide competing services to those offered by Sidewalk Labs.

Digital infrastructure role.
Sidewalk Labs plans to develop several components of digital infrastructure related to hardware, connectivity, and privacy, working alongside third parties to build out certain aspects of these systems.

For the proposed Wi-Fi network, Sidewalk Labs hopes to work with existing telecommunications companies with experience on the Toronto waterfront to build out infrastructure and conduct research and development of new technologies. Waterfront Toronto has worked for over a decade to eliminate the digital divide in their new communities, working with a local telecommunications provider to deliver gigabit service to every residential unit that gets built on public land, including in affordable housing.

For other infrastructure components, Sidewalk Labs expects to play a larger role that still involves others. These include standardized mounts that would reduce the cost of deploying digital innovations and an advanced optical network and software-defined network that makes connectivity faster and more secure. While Sidewalk Labs does not expect others to have sufficient incentives to create this infrastructure alone, it believes these components would play a critical role in boosting the success of digital innovations that address urban challenges.

Sidewalk Labs also expects third parties alone to provide other aspects of digital infrastructure that include 5G cellular connectivity (at much lower costs thanks to standardized mounts), other advanced communications networks, and additional privacy-enhancing infrastructure.

Digital services role.
To achieve fundamental quality-of-life goals through innovations the market has not pursued, Sidewalk Labs plans to offer a limited set of core digital services related to its essential programs for transportation, affordability, housing, energy, or public space. These services would rely on application-specific hardware devices created primarily by third parties but adapted or extended by Sidewalk Labs, working closely with these device manufacturers.

These launch services could still involve working with partners and buying existing technology. For example, the proposed mobility management system (see Page 452) could require computer-vision technology that performs de-identification at source, retaining an aggregate count of travellers but deleting any footage or images. Local companies are working on such technology, and Sidewalk Labs would explore options for purchasing those devices as this mobility system (or other proposed services) may require them.

Sidewalk Labs believes the urban data generated by these services would catalyze third parties to create countless other applications to improve quality of life, along with the application-specific hardware designed to support them.

For that to occur, this data must be shared publicly, and there are many companies and organizations in Toronto and beyond that specialize in making data available, such as ThinkData Works, the City of Toronto's Open Data Portal, and the Open City Network. Sidewalk Labs hopes to work with them to help provide the services necessary for the Sidewalk Toronto project.

Open and secure standards role.
Making data publicly available is necessary but not sufficient to catalyze digital innovation. That requires publishing the data in standard formats that third parties can easily build on, with good documentation for both the method of access and for interpreting the data format.

There are a small number of existing data formats for urban data, but Sidewalk Labs would focus on working with partners and standards bodies to develop, refine, and promulgate a much wider range of formats that support quality of life goals (see Page 403). Sidewalk Labs plans to take the same approach to standard communications protocols (such as software-defined networks), physical standards (such as standardized mounts), and security and resiliency standards (see Page 408).

Responsible data use role.
All digital innovations that propose to use or collect urban data in the IDEA District — whether developed by third parties or Sidewalk Labs — would be reviewed by and require approval from an independent Urban Data Trust (not controlled by Sidewalk Labs or Waterfront Toronto). These proposals would involve submitting an RDU Assessment to ensure that privacy and security are protected and that the innovations adhere to RDU Guidelines established by the Urban Data Trust. This proposed process would apply in addition to existing privacy laws.

Sidewalk Labs believes the Urban Data Trust could evolve into a public-sector or quasi-public agency over time.

By offering this unique set of catalyzing conditions in a defined geography, Sidewalk Labs hopes to encourage and invite countless urban innovators to view the IDEA District as a global launchpad for urban innovation.

Ch–5

Part 1

Providing More Affordable and Flexible Digital Infrastructure

Key Goals

1
Expand opportunity with ubiquitous connectivity

2
Reduce installation and maintenance costs with an "urban USB port"

3
Use distributed credential infrastructure to protect privacy

Digital infrastructure is a basic building block of the future city — the backbone of connectivity that helps residents, companies, organizations, and local agencies use data to launch new services that improve urban life. Many of the improvements to mobility, housing, energy use, and the public realm described throughout the MIDP are only possible today thanks to advances in digital infrastructure, such as fast internet connectivity and digital devices capable of collecting information.

Digital infrastructure is what enables an adaptive traffic light to prioritize a light rail vehicle that is running late, and what enables a heated bike lane to warm up in advance of a storm so a cyclist can get to work on a snow-free path. It is what enables an extendable awning to cover a ground-floor market space just before it rains, and what enables a small business to launch a pop-up at an affordable cost. It is what enables someone who suffers from asthma to request alerts whenever there is a decline in air quality, what enables a dishwasher to operate when energy is cleaner, and so much more.

Digital infrastructure is what unlocks these innovations, and more importantly, the significant leaps forward in affordability, mobility, sustainability, and opportunity that come with them. It is also the catalyst for new services or businesses no one has thought of yet, and the cornerstone of a digital economy. For the IDEA District to become both an inclusive neighbourhood that evolves over time and a hub for ongoing exploration into the next great idea for urban life, fast and low-cost connectivity should not be a luxury for the few — it should become the new standard.

But today's digital infrastructure can be expensive and difficult to replace. Too often, cities rely on proprietary hardware and software to collect data and connect people, locking them into using the same tools for years, even when better options become available. That makes it hard for residents, workers, and businesses to take advantage of the latest technologies that promise faster connections at lower costs.

Fast and low-cost connectivity should not be a luxury for the few — it should become the new standard.

Sidewalk Labs' proposal for digital infrastructure centres on two core hardware components. One is ubiquitous connectivity that would offer residents, workers, and businesses access to their own secure, super-fast internet network no matter where they are, at an affordable cost. The other is a new type of "urban USB port" that would provide a physical mount, power, and connectivity to digital devices in the public realm — such as Wi-Fi antennae, traffic counters, or air-quality sensors fixed to street poles and traffic signals — at much lower cost than the connected mounts cities use today.

Additionally, Sidewalk Labs plans to explore the use of a new type of privacy-preserving software infrastructure that would enable people to share only the minimum amount of information necessary to complete a transaction with a digital service or app, with the person's full consent.

These proposed components would not be exclusive; on the contrary, any third party could provide a competing offering.

At the neighbourhood scale of Quayside, ubiquitous connectivity could draw people outdoors, further bridge the digital divide, and provide secure access across the entire neighbourhood. However, this type of network would only become financially sustainable at a larger service area, given the number of residents or businesses needed to recoup the initial investment. Deployed at the full scale of the IDEA District, this advanced connectivity would dramatically reduce the time and effort required to set up networks and enable residents to use their own network everywhere — from their couch to a park bench.

Similarly, in Quayside, the proposed urban USB port would make it much easier and less expensive to deploy technology in the service of improving a neighbourhood. But new hardware standards require significant geographic distribution to gain the wide adoption needed for device manufacturers to incorporate the standard into their own designs; for example, a Wi-Fi antenna producer would not change its design for a small handful of cases. Deployed across the IDEA District, however, this standardized mount would reduce the time needed to mount a device in the public realm by 92 percent over current infrastructure.

At the full scale of the IDEA District, this approach to digital infrastructure would enable the creation of many urban innovations described throughout the MIDP — as well as all those waiting to be invented in the future.

Sidewalk Labs' role in digital infrastructure.

As explained on Page 382, in keeping with its role as catalyst, Sidewalk Labs would first look to others to help deliver its digital infrastructure proposals, including the proposed connectivity network, standardized mounts, and privacy-preserving software. Other infrastructure components, such as 5G, could be provided entirely by third parties.

Goal 1

Providing More Affordable
and Flexible Digital Infrastructure

Expand opportunity with ubiquitous connectivity

The internet is essential to modern cities: it is needed at all corners of a community at all times. To provide ubiquitous connectivity, Sidewalk Labs proposes a secure, high-speed, uninterrupted network across the IDEA District, both indoors and outdoors, that can support the use of roughly 10 million simultaneous devices.

Toronto's waterfront currently incorporates world-leading internet speeds, thanks to the work of Waterfront Toronto with its telecommunications partners. For example, in places like the Bentway, Waterfront Toronto has collaborated with telecommunications partners to provide free Wi-Fi as a way to extend digital access into the public realm.

Sidewalk Labs proposes to push this work even further by taking advantage of recent advances in fibre-optic technology and new approaches to network management. Sidewalk Labs would provide technical guidance and requirements and work with Waterfront Toronto's procured telecommunications partner to build out the required physical infrastructure and operate the network.

At the core of Sidewalk Labs' proposed network is the belief that residents, workers, and visitors should have continuous access to their own secure Wi-Fi connection everywhere they go, from the basement of an office building to sidewalk underpasses connecting the IDEA District with the rest of Toronto. This ubiquity would mean residents and workers can stay connected to their own home or office Wi-Fi network no matter where they are, without worrying about joining an insecure network.

This type of ubiquitous connectivity would also create new opportunities for small businesses and entrepreneurs to get up and running faster, and for residents and community groups to focus their energy in new directions, whether that means launching a pop-up retail shop, showing a digital media art installation, or finding a new job.

Advanced optical network

As part of its network planning, Sidewalk Labs is exploring a new technology called Super-PON (Passive Optical Network).

Conventional fibre-optic networks are constructed with a stranded fibre-optic cable running from the network provider's central office to the user's site, typically a single building. This type of system can reach 32 or 64 users per fibre strand,[5] with 20 kilometres of transmission reach.[6]

In contrast, Super-PON technology is capable of supporting 768 users per strand and extending the reach to 50 kilometres[7] — meaning that a single cable could now provide connectivity to multiple buildings across a neighbourhood or district. Super-PON achieves this improvement by splitting light into many different colours (or wavelengths) over a single strand of fibre-optic cable, with

Comparison

How Super-PON technology outperforms traditional fibre-optics on seven key metrics

	Typical network approach	Super-PON approach
Users per fibre strand	32–64	768
Maximum transmission distance	20 km	50 km
Wi-Fi signal interference	Signal interference from neighbouring homes and businesses degrades Wi-Fi connectivity, especially during peak usage	A continuously managed Wi-Fi signal optimizes for speed and coverage to prevent slowdowns, even at periods of heavy usage
Router configuration	Users independently configure their own routers	Configuration is automated and secure to simplify setup and increase security
Security	Firewalls configured per router, making access difficult and often opening security holes	Holistically configured routes that allow access for authorized uses only — simultaneously more convenient and more secure
Wi-Fi availability	Few public Wi-Fi access points; most access points configured for private access only; difficult to connect devices like smart switches, thermostats, lighting	Wi-Fi access points situated throughout the neighbourhood, indoors and outdoors, for seamless connectivity and access while remaining secure
Access to home or networks	Difficult to access when elsewhere without complicated, insecure custom configuration	Allows people to connect directly to devices in their homes, schools, and offices easily and securely using software-defined networks

each colour serving as its own signal.[8] In one possible configuration, each light wavelength (for example, red, yellow, or blue) would provide connectivity to a specific building.

This technology infrastructure could result in a higher-bandwidth network with a number of additional benefits. The ability to split cables among more users means the network would require less fibre material and physical infrastructure than traditional networks, enabling it to be constructed faster and at lower cost. The network would also use less electrical power because its extended reach requires fewer "stops" for a signal (a traditional network could require rooms with electric boosters every 20 kilometres).

This Super-PON specification is now being studied by the IEEE Standards Association,[9] the world's largest technical professional organization, for possible inclusion in its 802.3 international standards for telecommunications. If applied in Quayside, Super-PON would make Toronto the first Canadian city with this technology (it currently exists in San Antonio, Texas),[10] and would help ensure fast connectivity throughout the IDEA District.

Extensive fibre-optic backbone

Beginning in Quayside, Sidewalk Labs' proposed design for a fibre-optic backbone would be connected to two major internet Points of Presence (POPs) in downtown Toronto. The proposed designs would support at least 10 times the amount of anticipated bandwidth needed. Sidewalk Labs plans to evaluate whether an additional POP is required to provide sufficient redundancy.

The proposed network could support

10 times

the bandwidth needed in Quayside.

In Quayside, Sidewalk Labs proposes that the conduits holding the fibre have express and local routes, as well as regular handholes (access points). Each building would serve as an aggregation point for outdoor fixtures capable of mounting digital devices, such as street lights or poles, and would have fibre-optic runs to provide additional access if needed.

At the proposed full scale of the IDEA District, further enhancements could be possible, including laying out the fibre-optic backbone as a loop so that a fault at any location would not disrupt access further along the fibre.

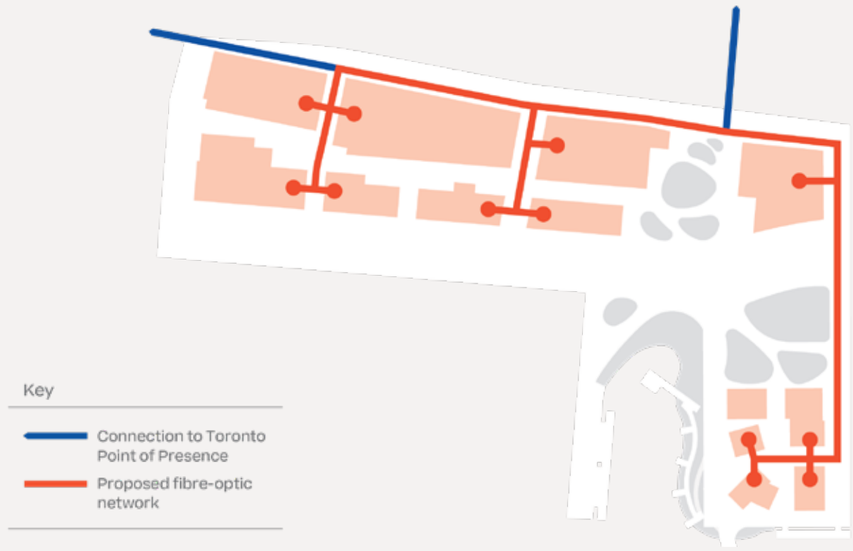
Flexible building connections

In Quayside, Sidewalk Labs plans to ensure that buildings conform to the following specifications that balance the goals of this Super-PON network with the ability for other providers to offer their own network services:

Conduits.

Sidewalk Labs proposes that incoming conduits meet a set of specifications provided to all developers, including buried depth, distance from water and sewer lines, slope from buildings, coating materials, size and amount, and duct plug features. These conduits should either run directly to a "Meet Me Room," or connect with the matching number of horizontal conduits that run to the Meet Me Room.

The proposed fibre-optic network would be designed to reach every building in Quayside



Meet Me Room.

This room would be a single location in the building where all communications-related equipment would be installed. It would be dedicated to communications use; other utilities should be located elsewhere to reduce risk of disruption of communications services. This room should have backup power and spare capacity for easy upgrades or new technologies.

Risers.

A vertical riser, dedicated to communications wiring, should be accessible on each floor and extend from base to the top floor and roof. The riser should be sized for future cabling. Ideally there would be two or more diverse risers that are separated by at least five metres for resiliency. Horizontal risers, on each floor, would connect each vertical riser to each individual unit.

Cabling.

Sidewalk Labs plans to implement Cat 6A wiring in each room for power-over-ethernet wireless access points, from a central point to form a local area network within the unit. This wiring would allow flexibility for installing additional radios — for example, the forthcoming 60 gigahertz products that offer multi-gigabit speed but whose signals cannot penetrate walls.

How it works: Super-PON connectivity

By splitting cables using new wavelength technology, Super-PON (Passive Optical Network) is capable of providing connectivity to multiple buildings across a neighbourhood or district.

B Each building gets a dedicated wavelength (colour) on a single fibre stand, helping to reduce materials, reduce infrastructure, and increase speed.

A Third-party Point of Presence.
The fibre-optic backbone would be connected to two major internet Points of Presence in downtown Toronto.

B Super-PON fibre.
A single Super-PON fibre strand can serve multiple buildings in a neighbourhood.

C Meet Me Room.
A location in each building dedicated to communications utilities.

D Vertical riser.
A pipe or channel for communications wiring should be accessible on each floor and sized for future cabling.

E Loop return.
A circular structure ensures better access and fewer service disruptions.

Optimized wireless infrastructure

Next-generation wireless systems could offer amazing speeds, but they actually require significantly more antennae and wired backhaul connections than today's systems. Sidewalk Labs is working to determine the optimal location for antennae, both inside buildings and throughout the public realm, using software that automatically takes the site plans for Quayside and creates a predictive radio frequency study. This study includes locating Wi-Fi access points, mobile phone antennae (such as 4G, 5G, LTE, and 3.5 GHz CBRS), LoRaWAN gateways, and more.

A seamless and secure neighbourhood-wide network

When the internet was invented in the 1970s, every device could connect to every other device.[11] "Routers" performed the task of getting packets of information from the transmitting device to the receiving one, usually by taking multiple hops. Over time, the internet became less connected: for security purposes, some sub-networks (subnets) walled themselves off by having the router that connected them to the rest of the internet reject most incoming information packets. This was the origin of the internet "firewall" — a now-common feature of an internet router.

For this reason, it is very difficult for people to connect to a home device when they are not at home. Instead, they must engage with a home device (such as a smart thermostat or home-security camera) via a third-party website or app that this device contacts from time to time.

Key Term

Software-defined networks

use software to create secure networks that remain accessible across a neighbourhood, providing greater convenience as well as heightened security.

To help address this challenge, Sidewalk Labs proposes to take advantage of an emerging security approach called "software-defined networks."

As its name suggests, a software-defined network uses software to "define" the way that information travels through the network's hardware (its physical communications links and the routers that connect them). In such a system, users would not need to configure their own routers independently and have those routers reject all incoming communications using a firewall. Instead, the software-defined system would automatically configure the routers to create private networks that would remain available and secure across an entire neighbourhood — providing both greater convenience and heightened security.

Greater convenience.
In Quayside, these private networks would be available anywhere in the neighbourhood, including in parks and public spaces, using the ubiquitous Wi-Fi network. Using a neighbourhood software-defined network would enable people to connect to all of the same devices regardless of whether they are at home, in the office, in the park, in a light rail vehicle — anywhere. And nobody else (unless authorized) would have access to those devices. A neighbourhood-wide software-defined network could also make set-up easier than the current set of routers and firewalls that internet service providers use.

Consider, for example, a family that wants to check on their pet while they are out. Right now they would normally have to make sure their in-home video camera was cloud-connected, because otherwise they would lose contact with their camera as soon as they were out of range of their home Wi-Fi access point. A better approach would enable the family to access this video using data from their home directly, just as if they were at home, without that data having to be transferred or stored at any cloud provider. And just as some people use a virtual private network (or VPN) to connect to their office network, there would be a way to connect to the neighbourhood SDN when they are outside the neighbourhood to maintain the same access.

Heightened security.
A further advantage of software-defined networks is security. Because the software network would know what kind of data each device is supposed to be transmitting, it would be able to detect if any of them have been compromised. For example, if a thermostat that normally sends a few bytes every minute starts streaming megabytes per second, the software-defined network could quickly disconnect the device from the network — putting it in a kind of quarantine. This ability could help avoid "distributed denial of service" attacks and other exploits aimed at vulnerabilities in connected devices.

As with all digital infrastructure proposed by Sidewalk Labs, residents and businesses would not be required to use this network.

Sidewalk Labs commitment

Digital infrastructure and inclusion

Building on the work of Waterfront Toronto to connect Toronto's waterfront communities, Sidewalk Labs plans to meet all the requirements for digital inclusion outlined by the National Digital Inclusion Alliance, a U.S.-based non-profit. Beyond affordable connectivity, these requirements include access to internet-enabled devices; quality technical support and digital literacy training; and applications designed to enable and encourage self-sufficiency, participation, and collaboration.

For those without smartphones or who require digital support, Sidewalk Labs plans to provide free-to-use devices, tech support staff, and digital literacy programming in the Civic Assembly and the Care Collective. This digital infrastructure would help the population seamlessly leverage digital tools for daily activities, advance in the digital jobs economy, and access critical services, such as government and healthcare support. It would also enable service providers to develop digital tools that they know can reach and support every community member.

To further encourage the development of truly inclusive tools, Sidewalk Labs is currently funding an inclusive usability testing program founded by Code for Canada called GRIT Toronto (see Page 443), working with local communities to develop a launch service aimed at participation in community decisions called Collab (see Page 446), and supporting Toronto-based service providers to develop technology solutions (see Page 382).

Goal 2

Providing More Affordable and Flexible Digital Infrastructure

Reduce installation and maintenance costs with an "urban USB port"

Sidewalk Labs has designed a standardized mount called "Koala" that would make it fast, inexpensive, and safe to install a device on a light pole or other street fixture by providing a sturdy physical mount, power, and network connectivity. Just as USB ports made it easier to connect external devices with computers, this new type of urban USB port would create a standard connection point for cities that drives down the cost of installing and maintaining digital hardware.

Today, according to public records, Toronto has at least 11,000 devices mounted to public infrastructure, including Wi-Fi access points, cellular nodes, environmental sensors, and traffic or public safety cameras.[12] Installing these devices often requires significant disruption to street life, creates risks to workers in bucket trucks, and costs thousands of dollars, because light poles and other street fixtures were never designed to host digital hardware.

Adding a single car-counting device to an intersection requires the city to take the following steps:

- Shut down a lane of traffic for hours or even days.
- Send a bucket truck with several staff to the intersection.
- Devise a creative mounting solution involving special clamps to adapt to the particular conditions of a traffic pole while maintaining safety standards.
- Employ an electrician to shut down the supply to the pole and possibly run a network wire up the pole, a process that might involve digging a trench to the nearest connection point.
- Repeat much of this labour-intensive process for repairs or upgrades.

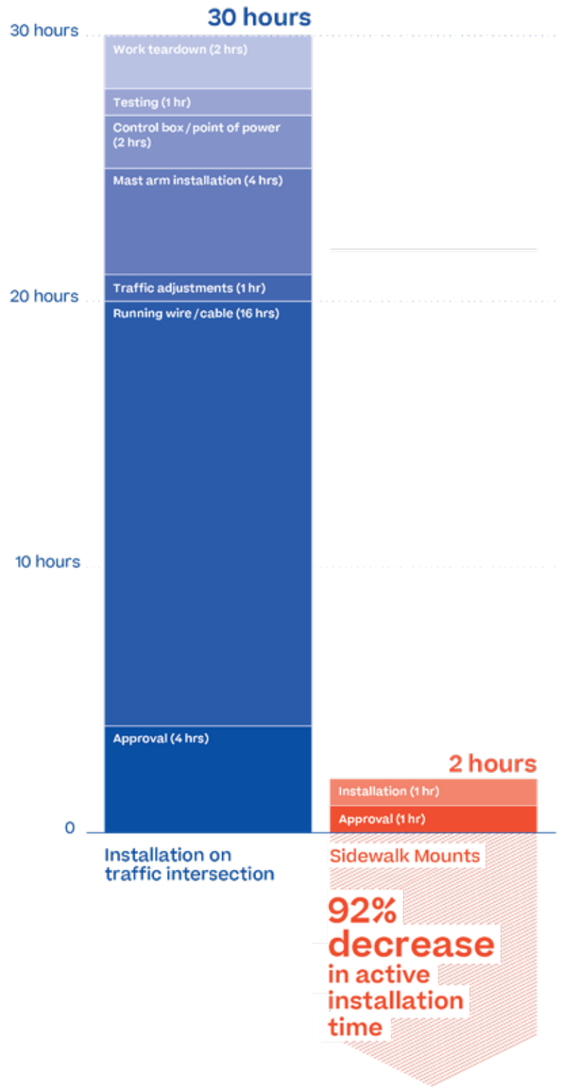
Because this process of deploying digital hardware is so onerous, cities (and the private vendors they hire) tend to invest in high-priced, ultra-reliable devices that are expensive to repair and upgrade. If it were possible to deploy, maintain, and upgrade such devices in an inexpensive way, cities could buy much less expensive technology, replace the small fraction of devices that fail, and provide some redundancy of devices to improve reliability around things like Wi-Fi networks. They would also be able to upgrade technology on a much more rapid timeline and have more resources to conduct pilots or explorations for new services.

Sidewalk Labs' Koala mounts would provide a low-cost, low-fuss way for cities or third parties to improve urban life using urban data collected in the public realm. (All such data use would be subject to the proposed responsible data use process described on Page 414 of this chapter.) Koala mounts would be designed to provide power and connectivity to devices without the need to run new electric wires or close down streets. On the contrary, a device could be installed quickly using a common ladder or even a reacher grabber. Sidewalk Labs estimates its mounts would reduce the time of installation by roughly 92 percent — down from 30 hours today to two hours.

Koala mounts would be designed to work with any devices that meet its published standards, just like a USB port. As with Sidewalk Labs' ubiquitous connectivity network, companies would be free to use other mount offerings or stick with the traditional approach.

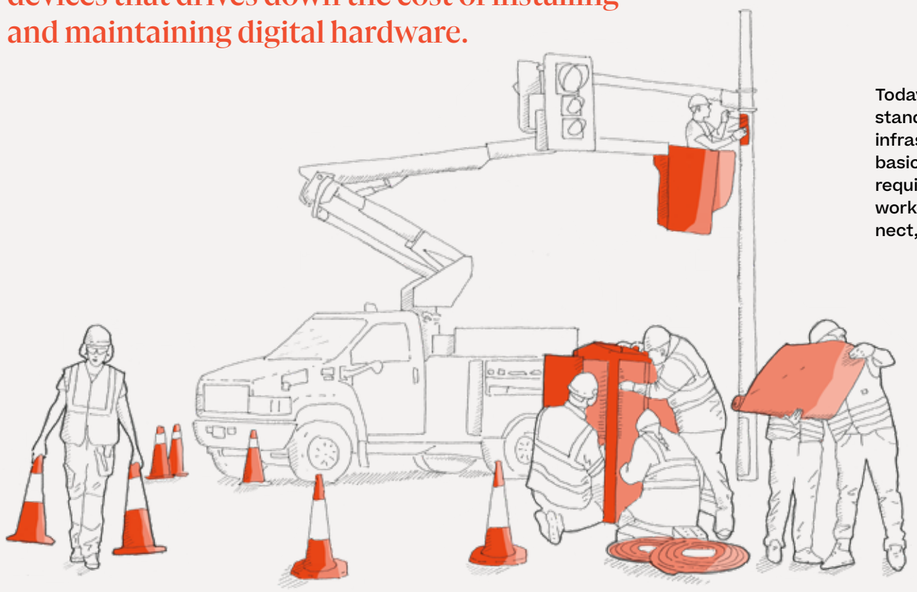
Device installation time savings of 92%

The proposed mount from Sidewalk Labs could dramatically reduce the amount of time it takes to install a device — down from 30 hours today to two hours. It could dramatically decrease costs, too. Assuming labour costs of $75 an hour, installing a device on a proposed mount would cost $150, compared with $1,980 for a standard traffic installation.

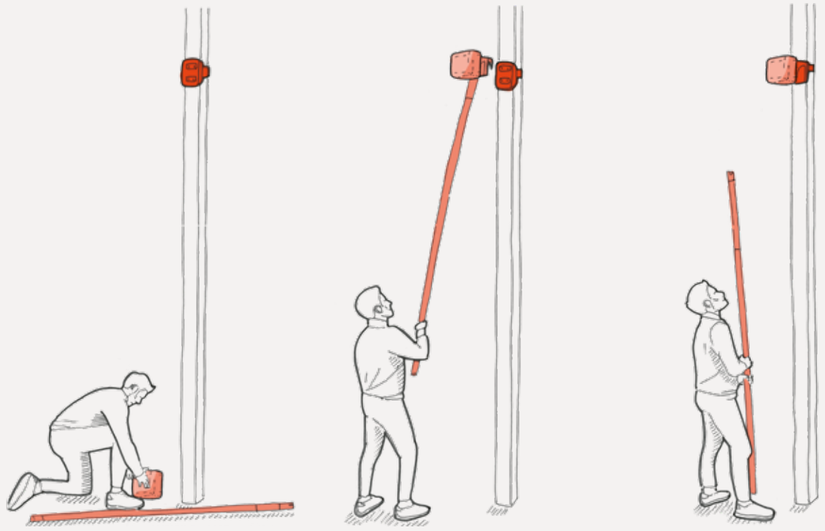


A standardized mount to reduce disruption

The proposal Koala mount would create a standard connection point for digital devices that drives down the cost of installing and maintaining digital hardware.



Today, without standardized digital infrastructure, even a basic traffic counter requires hours of work to mount, connect, and test.



Koala mounts would make it easy and quick to connect to a ubiquitous network and collect urban data for a multitude of purposes, from bicycle counting to air-quality monitoring to interactive public art installations.

Koala mounts would provide a low-cost, low-fuss way for cities or third parties to improve urban life using urban data.

Goal 3

Providing More Affordable
and Flexible Digital Infrastructure

Use distributed credential infrastructure to protect privacy

Many products and services in cities require some information about the people using them. But Sidewalk Labs believes that city residents, workers, and visitors should have to share no more information than absolutely necessary to use a digital service, receive a benefit, or conduct common personal or business transactions.

As an example, consider applying to rent an apartment. Potential tenants are often asked to reveal a lot of sensitive personal information as part of the rental application, such as their Social Insurance Number, driver's licence, tax history, and pay stubs.[13] But the minimum amount of essential information would likely include evidence of financial responsibility, such as recent credit history or score. It should not be necessary to include other information about the individual that could be used to discriminate against an applicant, such as their age or ethnicity.

To help tackle this challenge, Sidewalk Labs has been exploring the field of distributed digital credentials. This emerging approach uses privacy-preserving techniques to enable interactions such as the one described above in a way that provides only the minimal amount of information necessary, with a person's full consent over what information is shared.

Such privacy infrastructure is being developed by many groups around the world, including the open-source community, global organizations (such as the consortium piloting the DECODE project in Europe), startups, large financial institutions, and governments (for example, the Province of British Columbia). Sidewalk Labs plans to work with these types of groups to explore ways to incorporate this existing technology into many of its digital services that involve personal information, and to adopt a standard for handling personal data transactions in a trustworthy way.

This structure for digital services enables transactions between two parties that do not involve the creators of the digital services at all (whether Sidewalk Labs or another third party). Instead, credentials would be stored on user devices, not in the cloud (thus distributed, and not centralized), and the credential infrastructure would not act as an intermediary between the two parties. Continuing the rental application example, only the landlord and the rental applicant would ever have access to the information in their transaction.

In the rental application example, such a system could process a credential digitally signed by a trusted financial institution confirming the applicant's financial status without divulging further information that is not required for the application process — and with the applicant having full control over sharing this information.

Distributed credentials can ensure that people share the least information necessary to complete any digital transaction.

This interaction is enabled by technological advances in cryptography such as zero-knowledge proofs, digital signatures, and auditable data structures — which together make it possible for the applicant to prove their financial eligibility for an apartment without revealing data such as their name, address, or employer, all of which might bias a reviewer. In this case, zero-knowledge proofs allow the renter to prove their financial information is in an acceptable range without revealing exact values; the digital signature allows the reviewer to guarantee that the data is authentic and confirmed by a trusted counterparty like a bank; and auditable data structures give users the ability to make sure that no one has compromised their account or stolen their identity information.

In other words, only the people providing information about themselves and the service they are interacting with should know what is happening with the data involved — balancing the needs for privacy and authenticity for many types of urban interactions, both digital and physical.

Ch–5

Part 2

Setting Data Standards That Are Open and Secure

Key Goals

1
Enable third-party innovation with published standards

2
Use best-in-class resiliency and security

The ability to collect urban data is the first step to creating the conditions for digital innovation in the future city. But collection alone is not sufficient to use that information to create new services or tools that improve people's lives. To do that requires making the data publicly accessible to others in a way that encourages innovation but remains secure.

Perhaps the best example of a place catalyzing digital innovation via open standards is Estonia (see sidebar). The country's digital services platform, called "X-Road," makes it quick and easy for residents to do everything from apply for a bank loan to contest parking tickets to file their taxes.[14] And because the platform is publicly accessible through a published standard, the capital of Tallinn has become a hub of innovation in areas such as cybersecurity and blockchain technology.[15]

Standardized data formats, the kind that software developers can easily read and build on, are a key catalyst for digital innovation.

Of course, to create a vibrant ecosystem of new applications using data, that data must be provided in a standard format, with good documentation for both the method of access and for interpreting the data format. That is typically done through well-designed application programming interfaces, or APIs. APIs are standardized programming tools that enable computer systems to communicate; for example, when a Transit App shows bike-share availability at a nearby dock, it is using an API to connect with the bike-share system's real-time database, process that data, and display it on a phone.[16]

Key Term
APIs
are standardized programming tools that enable computer systems to communicate.

Currently, there is a gap between well-designed APIs and those of a typical open dataset. A well-designed API provides application developers with a clear description of the kind of data they can retrieve, the exact format the data will be provided in, sample code to access and use the data, and example applications that have been built using these same ingredients. That is not the way that the vast majority of open data is provided today. Making urban data available in ways that software developers can readily build on could provide the conditions for significantly increased innovation in city technology.

Global case study

How Estonia's "X-Road" makes lives easier

At the start of the 21st century, only about one-third of Estonia's population had ever used the internet.[17] Less than 20 years later, this small Baltic nation of 1.3 million people is home to the most advanced civic data system in the world.

Estonia's residents go online to vote, file taxes, apply for bank loans, share education transcripts, view health records, contest parking tickets, and more. Estonians do not need to register their kids for kindergarten; the system does it for them, based on their child's date of birth and home address. The pet e-registry tells them when it is time for another round of vaccinations. Estonians do not even carry driver's licences or vehicle registration papers with them when they drive.

The only thing Estonians need is their e-ID card, which comes with two PINs to ensure security. The first PIN is for personal authentication when citizens log on; the second is for their digital signature, when they need to approve online transactions. And all those transactions take place on X-Road: the secure, government-run data exchange where residents interact with businesses and government.

Instead of notifying multiple government offices of a change of address, Estonians do it once, in the population registry, and give X-Road permission to share it with the voter registry, health ministry, banking institutions, and so on. X-Road shares only what it is instructed to share. And every time a third party views a person's information, it is traceable via a blockchain-style distributed ledger. Estonians can not only view their own health records, but also see which physicians and specialists have accessed them as part of their care.

X-Road processes half a billion queries annually, leading to substantial cost and time savings.[18] Transactions and verifications that used to take hours are completed in seconds. The process of registering a new business in Estonia takes 18 minutes;[19] by contrast, the same process in Ontario takes roughly 20 business days.[20] The country's courtrooms, once backlogged, are now remarkably efficient. Prescriptions flow from physician to pharmacist, and patients need not wait to get them written or filled. A 2015 World Bank report calculated that X-Road saved Estonians a total of 2.8 million annual hours — the equivalent of 3,225 people working around the clock for a full year.

The development of X-Road has given Estonia a competitive advantage in technology industries, helping to foster a robust startup ecosystem and giving the capital city of Tallinn a global reputation as a leading innovation centre. Estonia is also exporting X-Road to countries such as Finland, Moldova, Panama, and others.[21] As former Estonian President Toomas Hendrik Ilves told the *New Yorker*: "It's very popular in countries that want — and not all do — transparency against corruption."

Discussions of open data must also recognize the potential security risks that come with it. Addressing these risks begins with the network itself; as described on Page 392, a software-defined network could provide a heightened level of security by monitoring the amount of data that a device is transmitting and shutting off access if it detects anomalous behaviour. But security is not about implementing a single measure; rather, it best occurs with an established process for resiliency, transparency, and vigilance.

Sidewalk Labs proposes to catalyze innovation through the use of urban data that is both open and secure. First, Sidewalk Labs plans to develop and apply a set of published standards around open architecture, access, and sources that enable third parties to build on top of available information. Second, in support of that effort, Sidewalk Labs plans to use best-in-class security and resiliency techniques that aim to prevent disruptions, detect risks, and rapidly restore services.

Deployed at the full scale of the IDEA District, this plan for open and secure urban data would enable a vibrant ecosystem of urban innovation for startups, government agencies, researchers, civic organizations, and anyone else.

Sidewalk Labs' role in data standards. As explained on Page 382, in its role as project catalyst, Sidewalk Labs would aim to partner or rely on existing tools to achieve its goals for standards and security, including working with the many companies and organizations in Toronto that specialize in providing data in standard formats.

Goal 1

Setting Data Standards That Are Open and Secure

Enable third-party innovation with published standards

Open architecture avoids the lock-in costs of proprietary systems.

At the core of Sidewalk Labs' approach to catalyze innovation is the belief in the importance of published standards for digital hardware and software, and public access to urban data that can reasonably be considered a public asset.

Openness is essential to provide new services that help improve quality of life and to inspire urban innovation by third parties. Just as no single company owns the web, no single company, organization, or agency should own the data or databases used by cities. They must be publicly accessible to improve upon, build on top of, or even replace.

Sidewalk Labs proposes a three-part plan to achieve its goal of a digitally open city. First, it proposes to provide data in standard formats and via well-defined, public APIs (open architecture), and where relevant standards do not exist, it would work with other companies, researchers, and standards bodies to create those standards. Second, it proposes to make this data publicly accessible by default (open access). Third, it proposes to make the software source code required for others to integrate with each of these systems publicly available under a free software licence (open source).

Open architecture: Public standards

All too often, today's cities buy bespoke, proprietary data systems from private vendors. The result is costly lock-in: the city must pay this provider forever for the use and support of the system or throw away the technology and pay a new provider for replacement.

For the Sidewalk Toronto project, any digital hardware and software that Sidewalk Labs creates would use public standards that make it possible not just to access data easily but also to replace aspects of the hardware or software itself, avoiding lock-in from a single technology provider and encouraging innovation.

This approach follows that of the World Wide Web. The reason that someone browsing the web can use any browser to view any web page, and that any web page could be served by any web server, is that the web is based on a collection of public, internationally recognized standards. These standards are a medley of letters: HTTP (how web pages can be requested), HTML (how text and images are specified), CSS (page formatting), SSL (security), and so on. Because these standards are universally followed, anyone with sufficient technical expertise can create a new version of any component of the web, including a new web server, a new web browser, or a new website.

Such standards have a number of advantages. First, they help ensure that no single company has a monopoly on providing a critical component. On the contrary, standards make it easy to improve — or even replace — any single component without throwing away the entire system.

Second, public standards inspire innovation. Web standards are now used for tasks that the creators never dreamed about. For example, standards originally designed for simple web pages are now used to support email, social networking, video-conferencing, virtual reality, and banking.

See the "Sustainability" chapter of Volume 2, on Page 296, for more details on the Brick standard.

Public data standards prevent any single company from monopolizing a critical digital system or component.

Where relevant standards exist, Sidewalk Labs plans to use them. These would likely include:

- GTFS Realtime, a standard for reporting the location of public transit vehicles within the neighbourhood in real time (see sidebar)
- General Bikeshare Feed Specification (GBFS), for reporting the availability of bike-share bikes and docks
- Brick, a standard for describing building infrastructure, including HVAC systems
- IFC, a standard for building information modelling, along with the Linked Data extensions
- OpenStreetMap, a representation of roads and other public realm infrastructure
- CityGML and CityJSON, standards for describing building shapes and sizes
- OpenTraffic and OpenLR, emerging standards for describing traffic and street segments
- Public Life Data Protocol, a standard from Gehl Institute on the use of public space

Sidewalk Labs commits to publishing an ongoing list of standards it uses, and proposes that the Urban Data Trust require other entities using urban data in the IDEA District to do the same.

Open architecture: APIs

Public data standards provide the lingua franca necessary for open architecture. Another important aspect is the methods by which data is exchanged via APIs.

As explained on Page 401, APIs provide a well-documented way for software developers to access public data. Too often today, even if a city makes its data publicly accessible, that data is too inconsistent and unpredictable to use without significant manual processing.

For example, if two entities collect the temperature in different parts of Toronto, an API would specify that both parties should use Celsius, collect the position of the data using latitude and longitude, and store the time in Coordinated Universal Time. If these parties did not agree to speak this common language before publishing their data, using that data correctly would be time-consuming and error-prone for software developers. The result would be that a startup or organization would have to invest a lot of money to standardize the data or, all too often, abandon an idea that might otherwise lead to a promising new service.

Sidewalk Labs plans to make its own APIs well-documented and publicly available, as well as to use public standards where they exist. Where public standards do not exist, Sidewalk Labs plans to work with others to define formats that could become standards in the future. Finally, Sidewalk Labs proposes that the Urban Data Trust ensure that other organizations and individual developers collecting and using urban data in the IDEA District do the same.

Innovation spotlight

GTFS: How transit riders get real-time trip data

Perhaps the best example of the power of open-data standards in an urban context is a format for transit data known as the General Transit Feed Specification, or GTFS. Its technical name notwithstanding, GTFS is easy to understand: it is what makes it possible for a navigation app to show users when the next streetcar, subway, or bus is scheduled to arrive.[22]

Not long ago, bus or subway riders standing on a street corner or platform had only the vaguest idea of when they would be on the move. The schedule posted in fine print on a pole offered no assurance. Their ride could be two, 20, or 200 minutes away.

Today, in most major North American cities, smartphone apps can tell riders when their transit vehicle is coming down to the minute, thanks in large part to GTFS. Initially developed in 2005 as a collaboration between Google and Portland, Oregon's TriMet transit agency, GTFS allows transit agencies and other developers to integrate static and real-time transit data into a wide variety of apps.[23]

GTFS has since served as the template for bike-share data (known as GBFS) and could do the same for everything from autonomous vehicle fleet movements to parking availability, allowing them to be integrated together. It is all part of a trend: providing better mobility not from more rail lines or asphalt, but from better and timelier information.

Open access

Publicly available data has enabled innovation across multiple industries by making it easy for students, researchers, and entrepreneurs to try out new ideas. To take one example, the openness of the web turbocharged research on information retrieval by providing access to public web pages. This research led to the creation of search engines, adding to the web ecosystem.

To take another example, in the late 1980s, the U.S. Census Bureau developed the Topologically Integrated Geographic Encoding and Referencing (TIGER) database to support the 1990 census.[24] The TIGER database describes land attributes, such as roads, buildings, rivers, and lakes. By releasing the data publicly, the census bureau enabled new services and products from digital mapping and navigation companies, such as NAVTEQ and TomTom, and eventually from online mapping services, such as MapQuest and Google Maps.

The time has come to prioritize not just the data that is easy to acquire and publish, but to gather and distribute data that will have the largest positive impact on quality of life. Sidewalk Labs believes that providing open access to data that has been expressly collected for the purpose of improving mobility, sustainability, accessibility, economic opportunity, and other aspects of urban life would have an even greater potential impact than much existing open data.

As described on Page 424, in the section on RDU Guidelines, Sidewalk Labs proposes that properly de-identified and non-personal urban data be made publicly accessible by default, enabling others to use it to create new services, tools, or products.

See the "Public Realm" chapter of Volume 2, on page 118, for more details on CommonSpace.

As an extension of this policy, Sidewalk Labs proposes that this information be integrated into existing open-data portals containing relevant urban data, including the Open Smart Cities Framework, the Toronto Open Data Portal, and the Ontario Open Data Catalogue — expanding access even further.

Open source

Once data is made publicly available in standardized formats through well-documented interfaces, anyone with sufficient expertise could, in principle, create innovations that integrate with urban infrastructure and digital services. But that does not make it easy. Parsing the standard formats, processing public data for particular common purposes, or communicating with APIs often takes a lot of time and effort — and reduces the likelihood that innovators will engage and succeed.

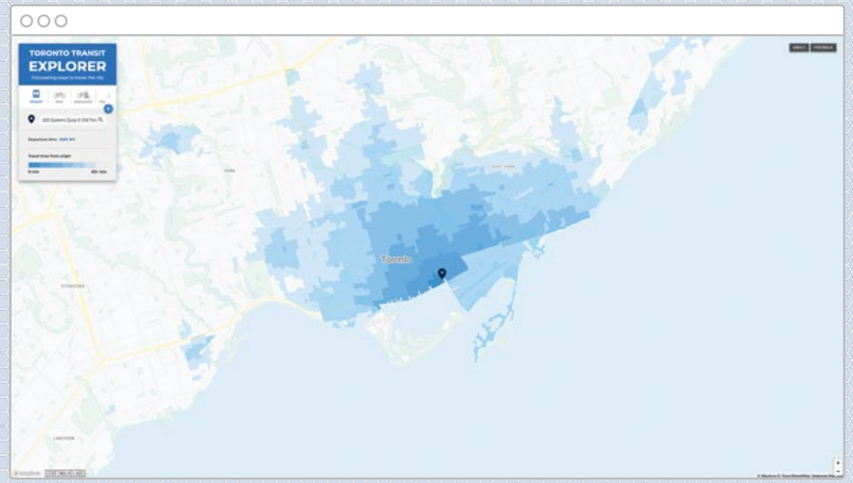
Where there are common tasks like these, Sidewalk Labs plans to share its software code publicly as "open source" — under licences like the Apache License (Version 2.0) or the MIT License — and encourage others to do the same. This approach has become common practice in the software industry, because it increases engagement with software systems. Over time, with contributions from software engineers across the world, this approach creates more robust and useful software.

In keeping with the belief that open-source tools inspire creative new uses, Sidewalk Labs has released several of its tools as open source, including the CommonSpace app for supporting public life studiesand the Toronto Transit Explorer prototype (available through the Sidewalk Toronto website). Sidewalk Labs plans to continue doing so in the future and to encourage others to do the same.

In Focus

Sidewalk Labs case study

Launching an open-source transit tool



The Toronto Transit Explorer's open-sourced data format, front-end visualization, and server code enable others to improve the tool over time.

As an exercise in getting to know Toronto, while using open data and open-source software, Sidewalk Labs developed and launched a tool called the Toronto Transit Explorer in 2018.[25] The tool lets Torontonians explore how easy it is to get from any point in Toronto to any other using a range of travel modes.

To create this tool, Sidewalk Labs improved an existing open-source transit router called R5, adding features such as the ability to combine bike-share and transit into a single trip, as well as the ability to filter for wheelchair-accessible transit. Sidewalk Labs published these changes publicly so others could take advantage of these improvements in the future.

Sidewalk Labs then created a web application for exploring Toronto's transportation options and a server that used the improved R5 router to calculate data on the fly for the user interface.

Early iterations of the app were shared at the first two Sidewalk Toronto Public Roundtables and at a Civic Tech Toronto meetup. This important community feedback led to a redesign that made it easier for people to choose their origin and destination points.

To enable others to take this work and create new apps and variations along similar lines, Sidewalk Labs open-sourced the Toronto Transit Explorer front-end visualization as well as the server code under the Apache License (Version 2.0). Sidewalk Labs has since received feature requests, code contributions, and ideas for improving the tool from doctoral students, urban planners, software engineers, and members of the Toronto community who saw the potential for using the tool in their own work.

Goal 2

Setting Data Standards
That Are Open and Secure

Use best-in-class resiliency and security

The digital systems and services proposed in the MIDP would help improve street safety, clean energy use, construction efficiency, and more. But connecting these systems creates new risks; intentional actions, inadvertent disruptions, even weather-related or environmental events could have a negative impact on digital services or infrastructure.

Planning for these risks requires a high level of security and reliability. Technologists often focus on digital security to prevent intentional acts. Sidewalk Labs plans to build on that foundation to ensure that the digital technology used in the IDEA District is resilient as well as secure. Digital systems should not only be secure from hackers — they should also be reliable in the face of inadvertent actions or environmental effects and maintained in a way that keeps them functioning at a consistent level over time.

Key Term

Security by design

refers to the principle that security should be considered at the beginning of the design process, rather than being an afterthought.

Sidewalk Labs' approach to digital reliability emphasizes three design goals. First, as much as possible, prevent disruptions and the loss of functionality. Second, rapidly detect any loss in functionality or increased risk of loss of functionality through audits and other approaches. And third, prepare to rapidly restore functionality to any service that experiences a disruption.

These priorities are modelled after the standard approach taken by government and municipal services to ensure the resilience of critical systems, and are parallel to the software architecture concept "security by design." Security by design refers to the principle that rather than being an afterthought, security should be considered at the beginning of the systems design process. This approach avoids designing a system or service in a way that makes security less effective or more difficult to implement.

Preventing disruption

Digital systems should, wherever possible, use public standards and open-source software with strong institutional and community support. This approach includes using tools like OpenSSL and the Linux kernel, which large organizations and governments around the world already depend on.

By using these tools, if a potential failure mode is discovered, a significant global community with a shared sense of urgency can help to address the issue. If any participating member of the community discovers a problem, all members can contribute to and benefit from the fix. Sidewalk Labs plans to use the Common Vulnerabilities and Exposures system — a public catalogue of security threats used by many other public- and private-sector digital service providers — to learn about and mitigate potential problems.

Additionally, Sidewalk Labs plans to give preference to the modularity of systems whenever possible, making it easier to isolate any component of a system that might experience a disruption and to replace any individual component with newer technology.

When open-source software is not available, Sidewalk Labs plans to develop tools in concert with the security community. This effort could include inviting security and reliability researchers to test various systems, following the industry practice of issuing "bug bounties" to researchers who responsibly disclose issues or help patch vulnerabilities. Sidewalk Labs plans to run regular tests with a "red team" to simulate security breaches and failures.

As new technology emerges, best practices change. That makes specific recommendations (such as using a certain encryption method) less appropriate, effective, and nimble than having a broad strategy to remain up-to-date with — and be able to adjust in response to — emerging recommendations by the security community. Sidewalk Labs plans to use this broader, more resilient approach for all the technologies it develops or maintains.

For example, when using cryptography, Sidewalk Labs would not develop its own methods of encryption, and instead would use algorithms certified by the Cryptographic Algorithm Validation Program, the cryptographic standards program run by the U.S. National Institute of Standards and Technology and the Canadian Communications Security Establishment. Similarly, Sidewalk Labs plans to follow security and reliability standards defined by the greater community, including two notable benchmark security standards, SOC2 and ISO27001, for applicable products and services.

Technical spotlight

Current Sidewalk Labs cybersecurity practices

Though best practices in cybersecurity are always evolving, there are a number that Sidewalk Labs follows today, including:

- Encrypting as much data as possible in storage and in transit using AES keys of 256 or 512 bits
- Storing keys in a key management system backed by FIPS 140-2 Level 3-certified hardware security modules
- Enabling client-managed encryption keys running on top of the same modules for any storage or computing resources to third parties
- Using HMAC to ensure message integrity with symmetric encryption
- Preferring elliptic-curve-based approaches over RSA for asymmetric encryption and digital signatures
- Using SHA-256 for general hashing and bcrypt for passwords
- Preferring multi-factor authentication methods over passwords alone
- Routing all traffic through TLS and, when that is not an option, physically partitioning devices from other networks

Detection and auditability

Ongoing auditability is an important way for the security community to confirm the integrity and reliability of a digital system. Sidewalk Labs plans to use auditing systems such as Trillian to achieve this objective and would closely follow the state of security research to maintain best-in-class approaches.

Additionally, Sidewalk Labs would have regular third-party audits of any platforms and code it maintains, not only to confirm that it is consistent in running the same software it shares but also to confirm that it meets the quality expected by the Urban Data Trust. As part of this effort, Sidewalk Labs plans to build both technical and policy-based controls to provide strong assurance to the community that the digital systems it implements are behaving consistently with the Urban Data Trust's expectations.

Another key approach to transparency and auditability is the use of modular systems. Modularity enables a high degree of transparency: even when data itself is encrypted, the amount of data being transferred between systems can be shared, when appropriate, to provide guarantees about what is being saved and transferred. For example, an auditor who sees a very low amount of data leaving a computer-vision camera would know that data is being processed on-site and that the raw video is being deleted — even while the data itself would not be visible to the auditing party.

Finally, Sidewalk Labs is eagerly evaluating the growing field of transparency and auditability for machine learning and artificial intelligence. As the field develops, Sidewalk Labs plans to synthesize findings and principles established as best practices in industry and academia. Broadly, Sidewalk Labs believes that machine learning should be as auditable and transparent in its decisions as traditional software and engineering are (see sidebar).

In the case of a disruption, practicality may require keeping information temporarily contained to the people managing the incident and relevant authorities; for example, security vulnerabilities need to be patched before they are shared. But Sidewalk Labs plans to give strong preference to publication, including regular external audits, and commits to sharing publicly full post-mortems of any incident or report once resolved or stabilized.

In Focus

Sidewalk Labs' commitment to "Responsible AI"

Many Canadians interact with artificial intelligence systems on a daily basis. Some applications of AI are as benign as email spam filters. Others carry more significant impacts, such as how banks approve loan applications.

One very common example of AI exists in "recommender" systems, which try to predict the preference or rating an individual would give to an item. Recommender systems function by collecting and analyzing the behaviour or activity of individuals and by comparing individuals to others who are similar to them. Many common recommender systems are considered helpful — for example, they can pre-populate a music playlist based on listening history. But some recommender systems can impact individuals in more significant ways or reveal potentially sensitive information about that individual.

The continued development and use of AI systems raises digital governance challenges that go beyond privacy. It is possible for organizations to be in full compliance with privacy laws yet still use data in ways that could impact people in harmful or unexpected ways.

To help protect against these unexpected outcomes and guide its use of AI, Sidewalk Labs has developed a Responsible AI framework guided by six overarching principles that are contextual, progressive, and applicable to all types of technology (existing and future). This framework is inspired by leading international standards, such as the Declaration on Ethics and Data Protection in Artificial Intelligence, which was signed by the Privacy Commissioner of Canada.[26]

(These principles would work alongside the proposed RDU Guidelines described on Page 424.)

Fairness and equity.
All projects involving AI systems should be designed and developed responsibly from the start and should consider an individual's reasonable expectations and the original purposes of data collection.

Accountability.
Organizations should always remain accountable for the AI systems they create and deploy.

Transparency and explainability.
Individuals should be informed when they are interacting directly with an automated system and when their personal information is being used to make consequential decisions about them. When feasible, AI systems should be designed with the ability to be explained in terms people can understand. In addition, AI inputs (or training sets) and potential biases should be understandable and debuggable.

Relevance.
All AI systems should be developed and designed with high standards of scientific excellence and with a multi-disciplinary approach that includes sharing research and best practices with regard to AI.

Value alignment.
AI systems should be designed, developed, and used in line with international human rights and local community values.

Respect for human dignity.
Individual autonomy and agency should be upheld through a diverse and multi-disciplinary design process. AI systems should be used to empower individuals and communities and enhance public engagement.

Preparedness and response

Designing plans for detection of or response to incidents requires anticipating potential issues (a practice known as “threat modelling”) and setting up processes for continuous readiness to respond to a service disruption.

Threat modelling is an iterative process that seeks to identify the assets of an application or service that are at risk of disruption. These assets are then reviewed for mitigations of potential issues (or “threats”) against their integrity. The risks posed by these threats are evaluated by taking into account factors such as the likelihood of some external factor triggering a disruption.

Response readiness focuses not only on preparing plans for responding to the threats generated in the modelling exercise, but also on ongoing drills to practice the plan. In many cases, this readiness requires staff, drills, and ongoing collaboration with external stakeholders to ensure that there are clear lines of communication in the event of an incident.

Each digital system that Sidewalk Labs implements for the Sidewalk Toronto project would use a preparedness assessment (see Page 413) to provide clear answers to key questions on threat modelling and response readiness. These assessments would be reviewed by a Sidewalk Labs security team as well as by parties that operate or maintain relevant dependent systems; for example, the potential for a problem with a traffic management system (an upstream system) requires designing a strong line of communication with emergency services (a downstream dependent).

Prioritize data residency

The decision on where to store data (known as data residency) is based on many considerations, including whether there is sufficient technical and physical architecture to store the data securely, the cost of storing the data abroad versus in the organization’s home country, and applicable laws.

As with all matters relating to data, Sidewalk Labs’ approach begins with a baseline that abides by existing laws. Canada’s federal private-sector privacy law does not require data to be stored or processed solely within Canada. Instead, it seeks to make organizations accountable by imposing obligations to ensure that data is properly safeguarded. Similarly, the federal and provincial public-sector privacy laws that may be applicable do not dictate data residency. Sidewalk Labs continues to monitor developments in this area, including the Office of the Privacy Commissioner of Canada’s consultation on the transborder flow of data, initiated April 9, 2019.

During the development of the MIDP, Sidewalk Labs engaged with numerous stakeholders and community interest groups to guide its approach to data residency, and heard clearly the desire to store data in Canada. For that reason, Sidewalk Labs commits to using its best efforts at data localization — for storage, processing, and communication — as long as there are Canadian-based providers who offer appropriate levels of security, redundancy, and reliability. To the extent that it is deemed infeasible to store data solely in Canada, Sidewalk Labs would be transparent about such a decision.

Information about data residency would be part of the proposed RDU Assessment (see Page 429) required for all parties.

In Focus

Preparedness assessments enable faster responses to security risks

To improve security and resiliency for digital systems, Sidewalk Labs plans to use a preparedness assessment. Such documents aim to identify security risks as well as mitigation approaches through questions around threat modelling and response readiness.

The questions on this page are included here for illustrative purposes only.

Threat modelling

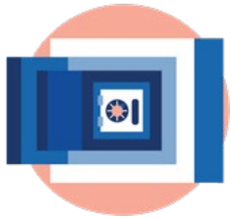
- What are the ways in which this service could be disrupted (such as partial outage, corrupted data, full outage, and illicit access or control)?
- Assess the likelihood of each disruption and (if available) any potential known ways that each disruption could be triggered.
- For each of these scenarios, will any systems external to the service be affected?
- For each of these scenarios, how will the disruption be detected? Could the disruption avoid detection?
- For each of these scenarios, are there up-front investments that can lessen their effect?
- For each potentially affected service listed above, what is the escalation path for notifying that service of a disruption?

Response readiness

- For each of the scenarios above, please provide a playbook describing a communication and mitigation plan.
- How regularly will there be drills practicing the protocol outlined in the playbook?
- Do these drills involve downstream and upstream stakeholders?
- Will there be “on call” staff available for response?
- **If no**, outline a response plan that obviates the necessity for staffing.
- **If yes**, outline the responsibilities and training for this staff. Also outline a continuity plan for maintaining this staff.

Ch–5

Part 3



Creating a Trusted Process for Responsible Data Use

Key Goals

1
Implement the Urban Data Trust

2
Establish RDU Guidelines

3
Set a clear process for urban data use or collection

In addition to flexible digital infrastructure and published standards, a third core condition for digital innovation is instilling community trust that information collected in cities will preserve the privacy of individuals and be used for the greater good — while promoting the growth of new businesses and the rise of new tools to improve urban life.

The pace of change for digital technologies such as the internet, social networks, and artificial intelligence has accelerated globally. When Canada established its federal private-sector privacy law, known as the Personal Information Protection and Electronic Documents Act (PIPEDA), some 20 years back,[27] just 42 percent of the population owned a personal computing device and smartphones did not exist.[28]

Canada is poised to lead a change. Canada recognizes privacy as a fundamental human right, with the right to privacy rooted in the Canadian Charter of Rights and Freedoms.[29] On top of that foundation, recent conversations convened by federal, provincial, and municipal regulators have called for stronger national and provincial data strategies that protect individual privacy while enabling companies to create valuable new services using data, rather than competing to own data outright.

All three levels of government are at various stages of consultations with the public. The Government of Canada launched national consultations on digital and data transformation in 2018.[30] Ontario launched its data strategy consultations in early 2019.[31] The City of Toronto also announced it would begin to develop a city-wide policy framework and governance model associated with digital infrastructure.[32]

The Sidewalk Toronto project itself has sparked significant conversations about a new approach to digital governance in cities, generating new ideas from Canadian experts, stakeholders, and the public. This ongoing, comprehensive engagement and consultation has shaped the ideas Sidewalk Labs is proposing in this MIDP and would continue to help them evolve with the project.

How public consultation shaped Sidewalk Labs' ideas

To receive guidance on a full range of issues relating to responsible data use, Sidewalk Labs convened a Data Governance Working Group made up of independent experts and community representatives. Sidewalk Labs and this group have benefited from other insights, including those of Waterfront Toronto's Digital Strategy Advisory Panel.[33] Sidewalk Labs also consulted with all levels of government, and met with the Office of the Privacy Commissioner of Canada, the Information and Privacy Commissioner of Ontario, and various departments within the City of Toronto.

Such collaboration has been critical, because there is no comprehensive and unified digital governance model in Canada for the type of community Sidewalk Labs hopes would emerge within the IDEA District. The aforementioned consultations being driven by the three levels of government represent important starts to this conversation, and Sidewalk Labs offers the proposal in this chapter for consideration.

Over the course of its own public consultation to date, Sidewalk Labs has heard three key themes that have helped shape its proposal.

Canada is poised to lead a global change when it comes to data governance strategies.

What we heard: Protect more data.
The first theme was a recognition that while it is paramount to protect personal information, as Canada's privacy laws currently do, individual privacy is only part of the discussion around responsible data use.

Existing privacy laws only apply to or protect "personal information," meaning information about an identifiable individual. Sidewalk Labs heard through its consultations that Torontonians are also concerned about the collection and use of data gathered in the city's public realm, publicly accessible spaces, and even some private spaces — whether or not that data identifies specific individuals.

This type of data collection merits special focus for a variety of reasons. Its collection in public spaces raises concerns about surveillance that are exacerbated by computer processing power and the proliferation of sophisticated digital tools, such as cameras and sensors. Certain types of this data might reasonably be considered a collective public asset. Individuals are also not always aware of either the collection or use of such data. For example, in the case of on-street pedestrian counters or lobby cameras, collection and use notices often lack adequate information to fully inform individuals, are not visible until the individual is within the field of view, do not consider language barriers, or are absent altogether.

Furthermore, Torontonians are concerned about how the collection and use of non-personal information could impact groups of people or the community. For example, federal privacy commissioner guidance encourages companies to consider the potential impacts that aggregated or de-identified data can have on individuals or communities at large, but companies could benefit from further guidance and comprehensive standards.[34]

How we responded:
A new category of "urban data."
For all these reasons, Sidewalk Labs proposes a new category of data called "urban data" that includes both personal information and information that is not connected to a particular individual. The term "urban data" nods to the fact that it is collected in a physical space in the city and may be associated with practical challenges in obtaining meaningful consent. Urban data therefore seems worthy of additional protections.

Urban data would be broader than the definition of personal information and include personal, non-personal, aggregate, or de-identified data (see sidebar) collected and used in physical or community spaces where meaningful consent prior to collection and use is hard, if not impossible, to obtain. In that sense, urban data would be distinct from more traditional forms of data, termed here "transaction data," in which individuals affirmatively — albeit with varying levels of understanding — provide information about themselves through websites, mobile phones, or paper documents.

The proposed responsible data use process would protect urban data while building on existing protections for personal information — knowing that both urban data and transaction data must be handled responsibly for a better city. Of course, the creation of a new term creates positives and negatives for companies and regulators alike, and Sidewalk Labs welcomes additional discourse on this term and its use in the context of the Sidewalk Toronto project.

In Focus

Explainer

Four types of urban data

There are different ways urban data can be categorized, each with different impacts on individuals and groups of people.

Non-personal data is data that does not identify an individual and can include other types of non-identifying data that is not about people. Some examples of non-personal data are aggregated data sets, machine-generated data (such as weather and temperature data), or data on maintenance needs for industrial machines. There are many benefits for consumers and members of industry to processing this type of data. The European Union recently passed a regulation protecting the free flow of non-personal data.[35] Even though non-personal data is not about identifiable individuals, it can still have unintended harmful impacts on people — for example, if AI systems use aggregated data sets to make predictions or recommendations to individuals.

Aggregate data is data that is about people in the aggregate and not about a particular individual. Aggregate-level data is useful for answering research questions about populations or groups of people. For example, aggregate counts of people in an office space can be used in combination with other data, such as weather data, to create an energy-efficiency program so consumption is controlled, with the goal of saving money and reducing energy use. As with other types of data, the use of this data can have bias and fairness consequences.

De-identified data is data about an individual that was identifiable when collected but has subsequently been made non-identifiable. Third-party apps and services may wish to use properly de-identified data for research purposes, such as comparing neighbourhood energy usage across a city. When data is de-identified correctly — using principles including k-anonymity, and frameworks such as differential privacy — it is no longer personal information. While de-identification of data may not completely eliminate the risk of the re-identification of a data set, when proper guidelines and techniques are followed, the process can produce data sets for which the risk of re-identification is very small. The Information and Privacy Commissioner of Ontario has released a set of De-identification Guidelines for Structured Data, which provide basic concepts of and techniques for de-identification. The guidelines highlight the key issues to consider when de-identifying personal information and provide a step-by-step process for removing personal information from data sets. The biggest risk of using de-identified data is that it is sometimes possible to link pieces of information together to re-identify the individual.[36] This risk can be mitigated by having trusted external experts regularly attempting re-identification in a controlled environment, in order to harden the system.

Personal information has a legal definition in Canada and is the subject of privacy laws, including PIPEDA.[37] The broad legal definition of personal information includes any information that could be used, alone or in combination with other information, to identify an individual or that is associated with an identifiable individual. Individuals routinely share their personal information with governments and businesses, whether applying for a licence or business permit, shopping, or ordering a ride-hail service. In some cases, personal information has to be shared to receive the service; for example, when people order food for delivery, the restaurant needs to know where to deliver it. Individuals often receive benefits from sharing their personal information, but society has seen many of the harms from illegal or unethical uses of personal information.

2

What we heard:
Consider urban data a public asset.
A second big theme heard during public consultation was that, in addition to personal and collective privacy, Torontonians are concerned with the ownership and stewardship of urban data.

Increasingly, some types of urban data can be understood as a community or collective asset. Take the example of traffic data. Since that data originates on public streets paid for by taxpayers, and since the use of that data could have an impact on how those streets operate in the future, that data should become a public resource.

In its extensive consultations with the public, stakeholders, government, and expert advisors, Sidewalk Labs heard that data collected in the public realm or in publicly owned spaces should not solely benefit the private or public sector; instead, it should benefit multiple stakeholders, provided any privacy risks have been properly minimized.

Part of using data responsibly involves making sure that no one entity — Sidewalk Labs or another — controls urban data that could reasonably be considered a public asset. The opportunities to use urban data to create new digital innovations must be available to everyone, from the local startup to the global corporation.

How we responded:
An independent Urban Data Trust.
If urban data is a common good, it should not be exclusively "owned" in the traditional sense. The question then becomes: Who should be the steward of urban data? Sidewalk Labs proposes that an independent entity called the Urban Data Trust manage urban data and make it publicly accessible by default (if properly de-identified).

As described on Page 420, part of this entity's responsibilities would involve establishing an accountable and transparent process for approving the use or collection of urban data in the first place, given the potential of urban data to impact people's daily lives.

3

What we heard:
Apply consistent guidelines.
A third major theme emphasized by public consultation was that Sidewalk Labs should not have a special advantage in the development of urban innovations. Quayside and the IDEA District must welcome all kinds of local companies, entrepreneurs, researchers, and civic organizations using urban data to improve life.

How we responded:
A single process for all parties.
The process proposed applies to all entities that seek to collect urban data in the IDEA District, including Sidewalk Labs.

The result: A proposed process for using urban data managed by an independent entity

These insights formed the basis of Sidewalk Labs' proposal for responsible data use, which builds on the strong foundation established by privacy laws and aims to establish an enhanced privacy standard.

Provincial and federal privacy commissioners would continue to oversee compliance with all privacy laws. Additionally, this proposal calls for the establishment of an independent Urban Data Trust, tasked first with establishing a set of RDU Guidelines that would apply to all entities seeking to collect or use urban data in the IDEA District and, second, with implementing and managing a four-step process for approving the responsible collection and use of urban data:

① ② ③ ④ **Step 1:**
Classify the data.
Does the proposed data activity involve urban data, and if so, does it involve personal information?

① ② ③ ④ **Step 2:**
Submit an RDU Assessment.
How would the data be used and collected? What measures, such as consent or de-identification, would be taken to ensure privacy and avoid harm?

① ② ③ ④ **Step 3:**
Receive a decision.
Do the benefits outweigh the risks enough to merit approval by the Urban Data Trust?

① ② ③ ④ **Step 4:**
Meet post-approval conditions.
Have devices been registered? How would access be facilitated? How would auditing occur?

The following sections describe the proposed implementation of the Urban Data Trust in greater detail, propose initial RDU Guidelines for consideration, and describe each of the proposed steps required when applying to use or collect urban data. This description is followed by two examples of how the process could work for digital innovations.

(This particular proposal is just one of many that should be considered on this important topic. Sidewalk Labs also supports the consideration of other recent proposals, including from MaRS[38] and the Toronto Region Board of Trade,[39] calling for independent entities whose mandate could be to govern data collection and use, provide oversight of digital technologies, enhance radical transparency for the placement of sensors in the public realm, and encourage that standards are published to enable third-party innovation.)

Goal 1

Creating a Trusted Process for Responsible Data Use

Implement the Urban Data Trust

Key Term

An independent **Urban Data Trust** would oversee all requests to use or collect urban data.

Sidewalk Labs proposes that the Urban Data Trust oversee matters of the digital governance of urban data for the IDEA District, including the approval and management of data collection devices placed in the public realm, as well as addressing the challenges and opportunities arising from data use, particularly those involving algorithmic decision-making. (Note that this entity is not intended to be a "trust" in the legal sense; see sidebar on Page 423.)

Sidewalk Labs believes the Urban Data Trust should be managed through a democratic process, but also recognizes that the novelty, complexity, and scale of this approach means that it could take some time to figure out how to appropriately implement the entity. For these reasons, Sidewalk Labs proposes that the Urban Data Trust could be implemented in two phases.

A first phase would be focused on getting the entity up and running quickly to establish the rules and give it experience working through use cases, perhaps first working through Sidewalk Labs' proposed use cases in Quayside; a second phase would work towards a more long-term solution.

Initial implementation period

Sidewalk Labs proposes that initially the Urban Data Trust be implemented through the final agreement between Waterfront Toronto and Sidewalk Labs. The agreement would call for the creation of the Urban Data Trust as the independent digital governing entity for the Sidewalk Toronto project (not controlled by either Sidewalk Labs or Waterfront Toronto). A key component of the agreement would require any organization requiring a permit to build or operate in the IDEA District to consider whether they plan to engage in data-gathering activities. If those activities would involve the collection or use of urban data, the agreement would require that the organization apply to the Urban Data Trust and obtain its approval before urban data collection and use could occur.

The agreement would also set up the structure of this initial Urban Data Trust and authorize that a non-profit entity be created with the charter to address the digital governance challenges related to urban data while also promoting data-driven innovations that benefit individuals and society. Sidewalk Labs proposes that this entity would have a board consisting of five members. The board initially could include a data governance, privacy, or intellectual property expert; a community representative; a public-sector representative; an academic representative; and a Canadian business industry representative.

The board could act in ways similar to Internal Review Boards or Research Ethics Boards in academic institutions for research, or to content moderation boards set up in-house at social media companies. In these examples, a team of experts are assembled to review and assess whether certain decisions should be made while balancing different interests. The independence of the board would be ensured by the application of best practices such as diverse representation of interests, term limits, staggering term lengths to ensure balanced succession, maintaining appropriate boundaries with clear conflict of interest policies, and other measures.

The proposed board would also hire (as an employee of the Urban Data Trust) a Chief Data Officer to run the entity's daily operations. This position could be filled by a data governance and privacy expert, potentially similar to the type of experience a former privacy commissioner might have.

Under the direction of the board and requiring its approval, the Chief Data Officer would be responsible for developing the charter for the Urban Data Trust; promulgating RDU Guidelines that apply to all parties proposing to collect urban data, and that respect existing privacy laws and guidelines but also seek to apply additional guidelines for addressing the unique aspects of urban data (see Page 424); structuring oversight and review processes; determining how the entity would be staffed, operated, and funded; developing initial agreements that would govern the use and sharing of urban data; and coordinating with privacy regulators and other key stakeholders, as necessary.

Sidewalk Labs anticipates that the Chief Data Officer would use a number of resources to inform its decisions, including the RDU Guidelines, the RDU Assessments (see Page 426) completed by proposed data collectors, published guidance from privacy regulators, and input from the board. The Chief Data Officer's decisions would be made to ensure that all actors in the IDEA District comply with applicable laws, such as PIPEDA and provincial or municipal privacy laws. The Chief Data Officer and the board would also develop protocols on when and how data could be stored outside of Canada.

Urban data agreements.
During the initial implementation period, the Urban Data Trust entity would enter into contracts with all entities, institutions, and organizations that are approved to collect or use urban data in the IDEA District. The contracts ("urban data agreements") could be similar to data sharing agreements or data licence agreements and include parameters that govern the collection, disclosure, storage, security, analysis, use, and destruction of urban data. Since these terms would be stipulated in the contracts, the breach of any term would be legally enforceable, with breaches actionable in court by the Urban Data Trust entity. The Urban Data Trust could also publish breach notifications about data collectors who fail to comply with the contract, and the contracts could potentially provide the entity with the right to enter onto property and remove sensors and other recording devices if breaches are identified.

Funding.
While the details on funding the initial implementation of the Urban Data Trust would need to be worked out in a consultation process, Sidewalk Labs proposes that as part of each contract, each party that desires to collect and use data in the designated geography pay a data collection and use administration fee to cover the costs of the Urban Data Trust. These costs would include salaries for the Chief Data Officer and the staff to manage applications, reviews, audits, and enforcement, as well as honoraria and other customary expenses for the board.

Longer-term options

After a certain period of time — once the Urban Data Trust has overseen the collection and use of data in the IDEA District and has gone through multiple use cases with provincial and federal privacy regulators — it is possible that other, more enduring arrangements could be implemented.

Looking long-term, Sidewalk Labs puts forth that the Urban Data Trust could be transformed into a public-sector agency or a quasi-public agency, either of which could give it more long-term viability or broader coverage.

Public-sector agencies receive their mandate from enabling legislation, are responsible for performing a public function or service, and are accountable to the minister responsible for that legislation. An advantage of transforming the Urban Data Trust into a public-sector agency is that the concept and process could then be applied to a wider group of organizations and places where similar technologies are being deployed. A disadvantage is that housing the Urban Data Trust in a public-sector entity would require new or amended legislation, and the passage of legislation can take time and would need to account for emerging technologies.

Sidewalk Labs notes that the Toronto Region Board of Trade recommended that the Toronto Public Library (a public-sector agency) be charged with the responsibility and authority for a Toronto Data Hub, citing the library's expertise in managing data and its credibility and trustworthiness to put the public interest first.[40] Sidewalk Labs supports a further review of this proposal.

Quasi-public bodies include entities that have been granted authority to act in the public interest, but that are at arm's length from government. For example, in Ontario, certain professions are governed by self-regulatory colleges, which regulate those professions in the public interest.[41] These colleges are responsible for ensuring that their regulated professionals act in a safe, professional, and ethical manner. They have the power to set practice and competency standards, investigate complaints about members, and, where appropriate, discipline members. The advantages of a quasi-public body include that it can act independently of government and that its reason for existence is to protect the public interest. A disadvantage is that these agencies are usually publicly funded until they can be fully self-funded.

Sidewalk Labs believes each of these options to be credible and worthy of further discussion in collaboration with Waterfront Toronto's Digital Strategy Advisory Panel, government, the community, academia, and industry.

Consultation spotlight

Why the "Civic Data Trust" became the "Urban Data Trust"

One of Sidewalk Labs' initial proposals for responsible data use called for an independent Civic Data Trust to be the steward of urban data.[42] Sidewalk Labs heard consistent feedback from many advisors and critics who felt that calling this entity a "trust" raised questions such as: "Who would be the trustee, and who are the beneficiaries?"

Sidewalk Labs notes that this entity is not intended to be a "trust" in the legal sense — legal trusts are not designed to benefit the general public. Instead, Sidewalk Labs aligns with the definition of a data trust from the Open Data Institute, a U.K. non-profit, as "a legal structure that provides for independent stewardship of data," as articulated in the institute's 2019 report, "Data trusts: lessons from three pilots."

While Sidewalk Labs proposes a non-profit entity, the final legal structure (and name) would be determined based on input from government, the community, researchers, and industry. Sidewalk Labs also now calls this entity the "Urban Data Trust" to clarify the proposed responsibilities.

Additionally, Sidewalk Labs heard that some people prefer to use the term "digital" rather than "data," as the considerations of an entity like the trust extend beyond data to all digital matters. Sidewalk Labs agrees and believes that the proposed RDU Guidelines and Assessment embrace this concept by assessing the broader issues arising from digital innovations and data ethics.

Goal 2

Creating a Trusted Process
for Responsible Data Use

Establish RDU Guidelines

Sidewalk Labs believes that an essential early step for the Chief Data Officer would be to create a set of RDU Guidelines that establish clear, common standards for responsible data use and can be applied consistently to all parties engaged in the collection and use of urban data.

The RDU Guidelines should address the concerns around privacy and data ownership that have been raised about the Sidewalk Toronto project, recognizing that similar concerns apply to other entities engaging in similar work. Rather than being constrictive, these rules should provide greater clarity and transparency to all innovators who want to set up shop and use data in a responsible way.

Sidewalk Labs believes the RDU Guidelines should build on the world-renowned approach to privacy called Privacy by Design, which outlines principles that should be implemented from the very beginning of a data activity to embed privacy protections into the design, operation, and management of a product, project, operation, or service.[43] But the proposed RDU Guidelines should go beyond privacy to address key areas of digital governance, ethics, and open access to information, as well as the ways in which aggregate or de-identified data can impact individuals and groups of people through the use of advanced analytics, such as artificial intelligence.

Key Term

Privacy by design

is a world-renowned approach to privacy that outlines principles that should be implemented from the very beginning of a data activity.

Sidewalk Labs believes the Urban Data Trust would be in a position to determine the most appropriate RDU Guidelines. For consideration as an initial set, however, Sidewalk Labs submits the following guidelines, which it has implemented internally for pilots that undergo privacy assessments:

Beneficial purpose.
All proposed uses of urban data must incorporate Canadian values of diversity, inclusion, and privacy as a fundamental human right. To meet this standard, there must be a clear purpose and value to any proposed use of urban data, as well as a clear, direct connection to the ways in which the project and proposed data collection activity would benefit individuals or the community. A proposal or project should not be collecting data for the sake of having data.

Transparency and clarity.
Organizations should inform individuals of how and why data would be collected and used, and should do so in a way that is proactive, clear, and easy to understand. Organizations should provide examples of how they plan to inform individuals about the data-collection activity.

Data minimization, security, and de-identification by default.
Organizations should collect the minimum amount of data needed to achieve the beneficial purpose and use the least invasive technology available to achieve the beneficial purpose. Organizations should seek to use up-to-date de-identification techniques to reduce the amount of personal information that they collect and use. Organizations should demonstrate the need for the amount of data to be collected and should be prepared to detail what, if any, personal information is desired; what they are planning to do with it; what safety and security safeguards would be used to protect individuals; and how these efforts would be audited.

Publicly accessible by default.
Organizations should make properly de-identified or non-personal data that they have collected publicly accessible to third parties by default, formatted according to open standards. This approach would help to ensure that individual privacy is preserved while also enabling data and source code to be accessible by others to catalyze innovation. Organizations should be prepared to detail their methods for making such data publicly accessible, and to justify any plans to restrict data access.

No selling or advertising without explicit consent.
While there would not be proposed prohibitions placed on data collectors who would like to sell data containing personal information or to use such data for advertising, a higher level of scrutiny should be placed on projects that want to use personal information for these purposes. Organizations that want to engage in this activity have an obligation to follow all applicable privacy laws; they should also provide clear justifications for this activity and demonstrate (with examples) how they plan to obtain explicit consent from the affected individuals. Such precautions are necessary because individuals often do not know when their personal information is being sold or used for such purposes.

(Sidewalk Labs has already committed publicly that it would not sell personal information to third parties or use it for advertising purposes. It also commits to not share personal information with third parties, including other Alphabet companies, without explicit consent.)

Responsible AI principles required.
To ensure that issues around the use of artificial intelligence systems are being considered and addressed by data collectors and developers, organizations should be required to detail if they are going to be developing AI systems. If so, they should be required to show how they have incorporated Responsible AI principles into their development and decision-making to reduce the likelihood of biased and unethical outcomes. (See Page 411 for more information.)

Goal 3

Creating a Trusted Process
for Responsible Data Use

Set a clear process for urban data use or collection

Sidewalk Labs proposes that once the Urban Data Trust and RDU Guidelines have been established, a transparent, four-step process should be created for any proposals seeking to collect or use urban data in the IDEA District.

① ② ③ ④ Step 1: Classify the data

Step 1 would involve the person or entity determining whether or not its proposal involves urban data, transaction data, or both types.

Urban data.
If the data activity involves the collection or use of urban data, then Sidewalk Labs proposes that the data collector must move on to Step 2 of the process, which calls for submitting an RDU Assessment to the Urban Data Trust (see sidebar on Page 428).

Urban data can include information collected in the public realm — defined as commonly shared spaces not owned by a private entity, such as streets, squares, plazas, parks, and open spaces — by devices such as pedestrian counters or traffic cameras. It can include information collected in privately owned but publicly accessible spaces, such as building lobbies, courtyards, some parks, ground-floor markets, and retail stores. And it can include information collected by a third party in private spaces, such as data on tenant or building noise, air quality, and energy use.

Transaction data.
If the data activity solely involves the collection and use of transaction data, then no assessment is required.

Transaction data is information that individuals consent to providing for commercial or government-operated services through a direct interaction, such as apps, websites, and product or service delivery. This data includes things like the credit card information a customer provides when signing up for a home delivery, an email address given to sign up for a local business's e-newsletter, or a phone number submitted to a banking app for text updates.

Sidewalk Labs believes that transaction data should not be under the Urban Data Trust's purview for several reasons. First, the data collector is already accountable under applicable privacy laws either to obtain consent to the collection and use of such data if the data is personal information or, if it is a public-sector entity, to ensure they have the proper legislated authority. Second, this type of data arguably is not uniquely connected to public spaces, nor is it generally considered a public asset requiring additional protections within the public interest.

This proposal to remove transaction data from the purview of the Urban Data Trust does not dismiss any ongoing concerns or questions that people have about the collection and use of transaction data in the areas of consent, transparency, and accountability, among others. Instead, it reflects the belief that incorporating transaction data into a governance model for the Sidewalk Toronto project would be unworkable given the lack of a relationship between this kind of data collection and a specific geography.

Sidewalk Labs appreciates that there would be ongoing dialogue about the scope of data collection and use under the Urban Data Trust's purview, and welcomes that dialogue.

(Even though this proposal does not place transaction data under the purview of the Urban Data Trust, Sidewalk Labs commits to applying the RDU Guidelines to any of its own commercially launched products and services that involve transaction data.)

Both types of data.
If the data activity involves the collection and use of both types of data, such activity would fall under the stewardship of the Urban Data Trust. One realistic example is an app-based ride-hail service whose vehicles are equipped with sensors or cameras capable of collecting data on passengers or the environment. While this organization's collection and use of data through the app would not fall under the jurisdiction of the Urban Data Trust, its collection and use of urban data through sensors and cameras would fall under that jurisdiction, thus requiring an RDU Assessment to be filed.

In Focus

Is it urban data?

The following questions can be used by public- or private-sector entities to ascertain whether the data they want to collect and use is subject to the Urban Data Trust process.

1 Is the data solely transaction data?

No — Please continue to Question 2.

Yes — This is not urban data. This is a traditional form of data that Sidewalk Labs calls "transaction data," which does not fall under the stewardship of the Urban Data Trust.

2 Is the data proposed to be collected within the IDEA District?

Yes — Please continue to Questions 3-5. If you answer yes to any of these questions, then the data is urban data and subject to the stewardship of the Urban Data Trust.

No — Your data will not be governed by the Urban Data Trust.

3 Is the data proposed to be collected in the public realm — on the street, in public squares, at plazas, in parks, or in open spaces?

Yes — Urban data.

No — Continue to next question.

4 Is the data proposed to be collected in privately owned spaces commonly used or accessed by the public — including building lobbies, privately owned but publicly operated parks, ground-floor markets, retail stores, or ride-hail vehicles?

Yes — Urban data.

No — Continue to next question.

5 Is the data proposed to be collected by a third party in an individual's private spaces or about an individual in their private spaces? (Examples include a building owner collecting noise, air quality, or energy-usage data on a tenant; a utility collecting data on a tenant's water consumption; or a building collecting information on tenant waste.)

Yes — Urban data.

No. This data is not urban data and will not be overseen by the Urban Data Trust.

① ② ③ ④ **Step 2:**

Submit an RDU Assessment

As a second step in the process, Sidewalk Labs proposes that entities, both public and private, seeking to collect or use urban data complete an RDU Assessment — an in-depth review outlining the purpose of the digital proposal, the type of urban data it aims to collect, its potential impact on the community, and its risks and benefits. This step would also apply to entities proposing to use urban data collected by an existing device for a new purpose. RDU Assessments would be conducted during the design phase, prior to urban data collection or use.

(Sidewalk Labs has been developing an RDU Assessment template since the summer of 2018, and it is currently used internally to assess the privacy compliance and responsible data use of pilots, projects, services, and products. This process requires collaboration from different teams to ensure that privacy is not just a compliance exercise and that privacy is truly done "by design" from the start.)

The entity applying for data collection would submit the RDU Assessment along with an application to the Urban Data Trust for review and approval. The Urban Data Trust would use the RDU Assessment to assess how the proposal conforms to the RDU Guidelines, privacy laws, Privacy by Design principles, and any other relevant factors or applicable laws. If necessary, the Urban Data Trust should help startups, companies, and organizations understand these factors when preparing the RDU Assessment.

The RDU Assessment would incorporate and build on one of the strongest existing data governance tools for protecting individual privacy: the "privacy impact assessment." A privacy impact assessment identifies any privacy and security risks associated with new digital technologies or data-related services, as well as how they are mitigated in the design of the project. All three orders of government currently require or encourage privacy impact assessments. Similar assessments are also a cornerstone of the General Data Protection Regulation, Europe's 2018 privacy initiative, which has raised the bar on responsible data use.

The proposed RDU Assessment would follow the same guidelines as a privacy impact assessment, attempting to identify potential privacy risks of new programs or services, to begin such an analysis at the outset of development, and to be adjusted and refined through stakeholder feedback. The RDU Assessment would exceed current privacy compliance requirements because it would consider the broader social and ethical considerations of new and existing technologies and their potential impact on people.

How the RDU Assessment relates to the RDU Guidelines

When assessing whether to approve a digital proposal, the Urban Data Trust would review an RDU Assessment and consider many factors, including how well the proposal conforms to the RDU Guidelines. Many of the example questions on this page have a close tie back to the guidelines.

Beneficial purpose

Transparency and clarity

Data minimization, security, and de-identification by default

Publicly accessible by default

No selling or advertising without explicit consent

Responsible AI principles required

Sidewalk Labs' proposed RDU Assessment includes four primary components:

Purpose.
The first section of the RDU Assessment would ask for a description of the purpose of the project, service, or product, including its objectives and goals, as well as the urban challenges it hopes to address. Examples of questions that might be asked in this part of the RDU Assessment might include:

- What is the objective for this project? Clearly state the problem that is being solved.
- Clearly state the measurable goal or outcome of the project.
- How likely are the proposed technology and collection and use of data to solve the problem as described?
- What are the alternatives to the technology or method of collection? Why are they not sufficient?

Data sources.
The second section of the RDU Assessment would require a description of the technology or data-collection methods, the data sources or types, and the parties who have access to the data. Some of the questions asked in this section might include:

- What are all the sources of the data, internal and external?
- Does the data activity involve personal information?
- Does this project involve the collection or use of data about people?
- Is the data stored in Canada? If not, is there a reason beyond business case or financial considerations that the data would not be stored in Canada?
- Is the data, or a subset of data, going to be used for advertising purposes?
- Is the data going to be sold to third parties?
- Will the data be matched against, combined with, or augmented by other data sets?

Legal compliance.
The third section of the RDU Assessment would capture conformance to applicable privacy laws. Examples of questions asked in this section might include:

- Have individuals been given choices about the collection of their personal information?
- Describe how the data activity complies with applicable privacy laws.
- If the data activity involves personal information, there must be explicit, express consent for collections, uses, or disclosures that: (i) involve sensitive information; (ii) are outside the reasonable expectations of the individual; and/or (iii) create a meaningful residual risk of significant harm. Please explain how you have achieved this requirement.
- Does the data activity include mechanisms that explain how data is used, how benefits and risks to individuals are associated with the processing, and how individuals may participate and object where appropriate?
- If the data activity includes personal information, how has it been de-identified?
- Is there a less privacy-invasive way to achieve the goals of the data activity (including potential insights)?
- What are the safety and security safeguards (such as encryption or internal access controls)? Is internal access audited?

Risk-benefit analysis.
The fourth section of the RDU Assessment would ask the proposing entity to detail and rate the risks and benefits associated with the project and data collection activity, and how any risks have been mitigated. Example questions might include:

- Could the anticipated use of technology harm or benefit certain individuals, groups of people, or communities in unintended or unexpected ways?
- What are the benefits to the individual or groups of individuals?
- How will this data-collection activity impact the community?
- Will the de-identified or non-personal data be made publicly accessible? If not, why?
- If personal data is being de-identified, when in its lifecycle is this done? How long is identifiable data retained on devices?
- Explain your external threat model and countermeasures.
- What format will the data be made available in? Is this format a public standard? If there is no relevant standard currently available, where is the documentation for the format that you will use? What partners or standards bodies do you plan to work with to promulgate this format?
- In this project, is the project owner using analytics-driven models, insights, or algorithmic decision-making that could impact individuals?

1 2 3 4 **Step 3:**

Receive a decision

Once the RDU Assessment is completed, the proposed data collector would submit it to the Urban Data Trust for review, assessment, and decision by the Chief Data Officer.

Balance benefits and risks.
Sidewalk Labs proposes that the Chief Data Officer look at all of the information the data collector provided in the RDU Assessment and determine whether the data activity should proceed based on the organization's attestation of compliance with applicable laws, as well as a subjective and objective assessment of the RDU Assessment that takes into account the appropriateness of the proposed data collection and uses and the resulting net balance of impact.

The Urban Data Trust would assess the balance of the proposed benefits and the potential harms, weighing their significance and likelihood of occurring against any mitigation efforts. The entity could also make use of published guidelines from the privacy commissioners regarding personal information; for example, if a data collector indicates that it plans to receive consent for the collection of personal information, the Urban Data Trust could look to the Office of the Privacy Commissioner of Canada's guidelines on meaningful consent to determine how closely they align with the data collector's proposed methods.

Similarly, if the data collector indicated that it plans to de-identify the data, the Urban Data Trust could look at the Information and Privacy Commissioner of Ontario's guidelines on de-identification for structured data, among other industry standards, to assess the techniques used by the data collector, as well as any standards established by the entity.

The Urban Data Trust could also interact with the data collector in a consultative process to the extent that additional information is needed to make the assessment or to assist the data collector in improving its data activity.

Final decision.
Sidewalk Labs proposes that a final decision be issued as "denied," "approved," or "approved with conditions."

Because the RDU Assessment is highly contextual and does not lend itself to black-and-white rules, several case studies have been included on Pages 436-440 to help readers understand how approval decisions could work in practice. Ultimately, the decision-making standards would be set by the Urban Data Trust.

A note on legal compliance.
An organization's approach to legal compliance would be part of the Urban Data Trust's decision-making process, but the organization itself would ultimately be responsible for legal compliance. Failure to abide by relevant privacy laws could result in enforcement action by the appropriate regulator and legal remedies imposed by the Urban Data Trust.

Of note: if personal information (as defined by PIPEDA) is involved in a proposal, the "legal compliance" section of the RDU Assessment would collect information detailing how the data is in compliance with privacy laws. The Urban Data Trust would not assess whether the organization is in compliance with Canadian laws, because under PIPEDA, organizations must remain accountable for the personal information they collect, use, and disclose. There are also practical reasons involving accountability and liability that account for why the Urban Data Trust should not be responsible for this compliance.

The Urban Data Trust could deny applications based on overt or apparent non-compliance. But the Urban Data Trust's opinion on legal compliance — for example, through the acceptance or rejection of an RDU Assessment based on PIPEDA compliance — should not be taken as validating compliance or as evidence or a ruling on legal compliance.

1 2 3 4 **Step 4:**

Meet post-approval conditions

As a final step in the process, Sidewalk Labs proposes that, once an entity or organization receives approval to collect or use urban data in the IDEA District, the Urban Data Trust should meet a set of post-approval conditions around transparency, device registration, data access, data sharing and licencing agreements, and auditing.

RDU Assessment transparency.
Sidewalk Labs proposes that the summaries of approved RDU Assessments be made publicly available by the Urban Data Trust to ensure transparency and encourage accountability by the public, privacy advocates, and regulators alike. Proprietary or confidential information, such as intellectual property or trade secrets, would not be published.

Device registry.
Sidewalk Labs proposes that, as part of the RDU Assessment filing and application process, entities must submit a map with the proposed locations of all data-collection devices, such as sensors or cameras. (This requirement would not apply to private owners or tenants of residential units or houses, such as those installing home security cameras for personal safety reasons.) Once the application including these locations has been approved, the entity must register these devices with the Urban Data Trust, which would upload the devices' locations and fields of view to an interactive map that would be publicly accessible. This registry would provide the public with a real-time inventory of information on what kind of data is being collected, as well as why, how, where, and by whom.

Facilitating access.
Sidewalk Labs believes that, in line with its proposed RDU Guidelines, properly de-identified, aggregate, or non-personal urban data should be made publicly accessible by default. Public access to urban data is crucial to innovation, equity, and the provision of digital services that improve quality of life.

If the data or source code were to be made publicly available, the Urban Data Trust would manage this access through data sharing agreements and facilitate integration with existing open-data portals and tools.

Facilitating access could be accomplished in a variety of ways, from having the Urban Data Trust actually hold the data to having it set rules that require collectors to publish de-identified, aggregate, or non-personal data in real time. This access should be free for basic use, but reasonable fees could be applied for commercial purposes or heavy use.

Access restrictions.
Data sharing agreements would also include information about any access restrictions approved by the Urban Data Trust. There could be cases when urban data cannot be released publicly for a variety of reasons. These cases could involve data that contains personal information — for example, a government organization that collects transponder data or images of licence plate numbers for enforcement.

Other cases could involve proprietary data collected at great cost to a company. The public release of such data would undermine investment and competitive advantage, discouraging businesses from locating within the IDEA District.

For example, consider a company building an alternative robotic delivery system for transporting packages and items to and from a storage facility. For robots to be able to navigate tunnels, sidewalks, building entrances, lobbies, elevators, and hallways, they would need to know where they are at any given moment with a high level of precision. Existing positioning technology like GPS or Wi-Fi triangulation would be too coarse — especially in urban environments, where GPS signals are often blocked by buildings. Recent developments in positioning technology can provide accuracy within a few millimetres, but significant investment would be required to deploy transmitters throughout the neighbourhood.

While this type of location data would technically occur within the public realm, the considerable cost of compiling it — and the likelihood that the company would either choose to pursue the project elsewhere, or not at all, if forced to make the data available, in real time, to its competitors — could merit a proprietary restriction in the view of the Urban Data Trust. The entity would still be able to audit the data collection and use, and the RDU Assessment summary would be publicly accessible.

Data sharing and licencing agreements.
As described on Page 421, Sidewalk Labs proposes that the Urban Data Trust facilitate access to urban data via data sharing agreements, including the terms of any potential restrictions or licencing fees.

In these cases, the Urban Data Trust would first make a determination about whether or not access to the data should be restricted, and then negotiate the terms of this restriction with the company or entity. These terms might include making the data accessible through an agreed-upon licencing fee, endowing the Urban Data Trust with rights to facilitate access based on certain specifications, requiring permission from the original entity for another party to access the data, or potentially even prohibiting access.

From that point forward, any entity seeking access to this data would have to apply for approval through an RDU Assessment, agreeing to abide by the negotiated access or licencing terms.

Data sharing agreements would also include a copy of the RDU Assessment and application, fees payable to the Urban Data Trust, the rationale for retaining any data in an identifiable manner, details on how the organization or entity would be audited, details on any certification marks the organization has obtained for its practices or project, and a limitation of liability and indemnification to the Urban Data Trust.

Auditing and enforcement.
The Urban Data Trust should retain the authority to audit all collections and uses as needed and order the removal of digital devices in the event it discovers a violation. The terms of auditing would depend on factors such as the sensitivity of the data, the track record of the organization, and the uses of the data, including whether advanced data analytics would be run on the data and whether the organization plans to use the data for ads based on consent obtained.

The Urban Data Trust would be able to seek legal remedies for violation of agreed-to conditions of data collection and data use.

The question of more traditional enforcement authority should be considered as part of the ongoing consultation for this work — for example, auditing could occur with the assistance of privacy regulators or via contractual agreements.

How it works: RDU Assessment case studies

It can be hard to talk about digital governance in the abstract. While the proposed Urban Data Trust would ultimately create its own governance standards and guidelines, the following illustrative examples are presented here to help guide readers through the responsible data use process and to give a broad sense of how decisions around responsible data use could be made. The process described here would apply to any public or private entity proposing to collect or use urban data in the IDEA District, including Sidewalk Labs.

1

Example #1: A mobility management system

A private company proposes to launch a mobility management system, working in collaboration with the city's transportation department.

The proposed mobility management system could help coordinate all the roads, traffic signals, curbside loading zones, and trip options, ensuring a safe and efficient travel experience for residents, workers, and visitors. To work properly, such a system would need to collect real-time information on mobility-related measures such as traffic volume (for pedestrians, cyclists, transit riders, and cars alike), transit delays, curb demand, parking demand, route closures, emergency dispatches, weather patterns, and more. This information would help the system do things like set prices for pick-up and drop-off zones to reduce congestion, or hold traffic signals for pedestrians who need more time to cross the street.

① ② ③ ④ **Step 1:**

Classify the data

The proposed mobility management system would operate in Quayside. It would require the placement of sensors and devices in public spaces, including on traffic signals, such that individuals would not have the practical opportunity to provide prior meaningful consent for the collection and use of this data.

For these reasons, the data collected would be considered "urban data." The proposal should advance to Step 2.

① ② ③ ④ **Step 2:**

Submit an RDU Assessment

Because the mobility management system seeks to collect and use urban data, it must complete an RDU Assessment. This assessment, plus an application, must be filed with the Urban Data Trust and approved before the service can launch.

The RDU Assessment would help the Urban Data Trust assess how well the proposed mobility management system conforms to relevant decision factors, such as the RDU Guidelines, applicable privacy laws, and Privacy by Design principles. Some of the relevant details from the assessment could include:

- The proposed system has a clear beneficial purpose, with an aim toward improving public safety, traffic congestion, and travel times.
- Much of the data required to run the system is non-personal, such as sensors to detect available curb spaces. The system also uses de-identified data by computing aggregate counts of pedestrians, cyclists, and vehicles directly on the camera and immediately deleting any raw video footage, safeguarding the privacy of individuals who might be visible in the raw footage. Together these efforts reflect Privacy by Design principles and data minimization.
- The city also proposes to collect some personal information (such as transponder information or licence plate images) for enforcement of curb rules; the city would attest to compliance with the applicable laws, including the Municipal Freedom of Information and Protection of Privacy Act.
- The information collected by the system would not be sold for advertising purposes or used for behavioural tracking purposes.
- While direct consent would not be possible for traffic signal information, the system would submit a map with the proposed placement of all mobility-related sensors to the Urban Data Trust so people could know the locations and purposes of the devices, improving transparency.
- Non-personal data would be made publicly accessible to others. Some access to de-identified data is proposed to be restricted as the system trains and tests its algorithm, to safeguard privacy and security.
- The system's cameras would use computer vision to de-identify pedestrians, cyclists, and vehicles at the source. Some de-identified information would be kept for an indefinite period to help train the algorithm to properly de-identify images. The data would only be accessible by key personnel with valid reasons to access the data for quality assurance and security purposes. Because data would be used by an algorithm and to influence decisions, Responsible AI guidelines should be considered in the assessment of this technology and proposed data use.

① ② Step 3:
③ ④ ## Receive a decision

As a next step, the Urban Data Trust would review the RDU Assessment and the application. Again, the Urban Data Trust should establish its own decision-making guidelines, but based on the proposed RDU Guidelines, this particular proposal would seem to meet criteria for approval, given the balance of benefits to risks.

Benefits: The system proposes to help achieve a reduction in traffic congestion, an increase in public transit ridership, and reductions in carbon emissions related to driving. The resulting accessibility of aggregate, non-personal, and de-identified data made publicly available would ease traffic and provide new opportunities to develop safety devices and applications. The data controllers would plan to store data in Canada.

Risks: The personal information collected as part of the system could be used to identify location patterns and schedules, including access by law enforcement and civil discovery. Other risks could include the de-identification process and the retention period of some of the images for calibration.

Decision: Given the proposed RDU Guidelines, the Urban Data Trust would likely approve this data activity, given its clear benefits and its proposals to effectively manage risks, which would include using the minimum amount of data, de-identifying data at the source, and ensuring any personal information collected by the city is secured and encrypted. The data controllers would also attest that the data activities are in conformance with applicable privacy laws.

① ② Step 4:
③ ④ ## Meet post-approval conditions

Once approved, the data collectors would register the data-collection devices to the publicly accessible device registry. The data collectors would still work with the Urban Data Trust to meet post-approval conditions around transparency, data access, and auditing.

Transparency: The summary RDU Assessment would be made publicly available.

Device registration: All devices would be registered with the Urban Data Trust and placed on a publicly accessible map.

Data access: Non-personal and aggregate data is made publicly accessible via the city's open-data portal. For example, a researcher could study this data to detect near misses between cars and pedestrians, and evaluate the performance of intersection designs on street safety.

Data sharing agreements: While access to properly de-identified data would be restricted to train the algorithm, the Urban Data Trust recommends that once testing is complete, the data and source code be made open so the benefits can spread. For example, a self-driving technology startup could use the same type of insights to create an improved pedestrian detection system. Personal information that would be collected and used by the city would not be made publicly accessible.

Auditing: The Urban Data Trust could decide that it would audit the system's de-identification techniques once in the next year. The Urban Data Trust could also recommend that the company retain an external auditing company to assess its de-identification techniques.

2

Example #2: An automated parking payment system

A private parking garage owner proposes to install CCTV cameras for security purposes, and to use the data to create an automated payment system as drivers enter and leave the garage. The cameras are capable of reading licence plates and capturing images of drivers and passengers. The garage owner does not plan to de-identify these images. The garage owner also plans to share the data with a data broker for a fee.

Individuals who are regular users of the parking garage could opt in to this system for automatic payment. Individuals who use the garage as one-offs and who do not opt in to (or even know about) this service would also have their licence plates captured, although these customers must pay for parking using a parking app or with cash.

① ② Step 1:
③ ④ ## Classify the data

The proposed parking payment system would operate within the IDEA District. The placement of cameras would be in a privately owned public space, and individuals would not have the opportunity to provide explicit consent for the collection and use of their data. Additionally, the payment system would be linked to an individual's credit card or parking app account.

For these reasons, the data collected would be considered "urban data" as well as "transaction data," and the proposal should advance to Step 2.

① ② Step 2:
③ ④ ## Submit an RDU Assessment

Because the proposal seeks to collect and use urban data, the parking garage owner must file an RDU Assessment and an application with the Urban Data Trust for approval before the service can launch.

For this illustrative example, some of the relevant details from the assessment could include:

- The garage owner claims a beneficial purpose for the proposal related to security and automated billing for customers. The garage owner would like to sell the data to a data broker, claiming this would benefit customers by offsetting fees to help keep parking prices low. However, selling data to third parties without explicit consent from the individual is in violation of RDU Guidelines.
- The garage owner intends to provide notice of the cameras with "CCTV signs" posted around the garage, achieving some transparency. There would also be information printed on the back of the parking garage ticket on how the data is used and directing the user to the garage website, where a more complete description of the data practice would be available.
- The garage owner attests compliance with PIPEDA and any other applicable law on the application form accompanying the RDU Assessment.

- The video stream would be available to the parking lot attendant when in the office and would be kept in the case of an incident and subsequent examination by authorities for a period of two weeks. Because the purpose for data collection is to deter or investigate safety and security incidents, there would be no obligation to de-identify the footage, and this use would be permissible by Canadian laws, as long as the Office of the Privacy Commissioner's guidance on video surveillance is followed. But the parking garage owner also proposes to use the video footage for another purpose (selling to data brokers) without obtaining consent and would not de-identify this data.

- While the parking garage owner acknowledges that sharing personal information with a data broker would likely be surprising to individuals, the owner does not detail any risk mitigation efforts, claiming that the risks would be necessary and justified by the benefits.

① ② **Step 3:**
③ ④ ## Receive a decision

As a next step, the Urban Data Trust would review the RDU Assessment and the application. Once again, the entity should establish its own decision-making guidelines, but based on the proposed guidelines, this particular proposal would likely be denied, given that its risks outweigh its benefits and that the data activity does not comply with RDU Guidelines.

Reasons: The data activity, as a whole, would stand in violation of the RDU Guidelines by selling data for advertising purposes or to third parties without consent and not de-identifying the data used for this purpose by default. The rationale for not de-identifying by default would likely not be compelling, as there were no actions taken to mitigate the risk.

The Chief Data Officer would likely consider the data activity, as a whole, in violation of PIPEDA, as the garage owner did not specify in the legal compliance law section of the RDU Assessment that they had obtained consent from the vehicles' owners, and also proposes to sell personal information without consent.

Conditions: The garage owner would have the opportunity to resubmit the RDU Assessment and application after consultation with the Urban Data Trust. Unless and until the RDU Assessment and application gains approval, the garage owner would not be able to install the CCTV cameras and begin collecting data. If an audit discovered that CCTV cameras had been placed in the garage and had started to collect data, the garage owner could be sued for breach of the contract entered into upon leasing the garage in the IDEA District.

① ② **Step 4:**
③ ④ ## Meet post-approval conditions

In this case, failure to gain approval would mean the proposal would not advance to Step 4.

The Urban Data Trust would help ensure privacy protections, make urban data a public asset, apply consistent and transparent guidelines, and be publicly accountable to all Torontonians.

Ch–5

Part 4

Launching Core Digital Services That Others Can Build On

Spotlights

1
An outcome-based building code system to enable a safe, vibrant mix of uses

2
An Office Scheduler to optimize energy use

3
A mobility management system to reduce congestion and improve safety

Digital infrastructure, published standards, and a trusted responsible data use process together set the foundation for digital innovation. But a true ecosystem of urban innovation requires a catalyst that makes it possible for third parties to build new digital applications, services, products, or tools that improve people's lives.

To serve as that catalyst, Sidewalk Labs proposes to launch core digital services that are essential to achieving quality-of-life objectives from Day One in Quayside (see table on Page 444). These launch services would not only deliver improvements to affordability, mobility, sustainability, and economic opportunity, but also would make the urban data they generate accessible to others — enabling countless subsequent innovations to emerge from local companies, entrepreneurs, startups, researchers, agencies, civic groups, and others.

These proposed core digital services would have a multiplier effect, since making their non-personal, aggregate, or de-identified urban data publicly accessible would catalyze digital innovations by a wide and growing range of third parties, inspiring a new generation of tools for city living:

- The shipping company that uses micro-location data to develop a robot that can deliver packages straight to a person's door
- The mobility entrepreneur who uses trip data on shared rides to launch a shuttle service with on-demand beach chairs and umbrellas
- The retailer who pairs foot-traffic data with weather information to identify the best locations or times for pop-up vendors to set up shop
- The environmental researcher who uses building data to recognize common recycling mistakes and teams up with a digital fabrication studio to design a more sustainable coffee-cup lid piloted by local restaurants

The list is truly endless. Just as no one could have expected that a satellite-positioning system would eventually change the way people hail a cab, ride a bike, order food, meet with friends, take pictures, or even find romance — digital services have the power to enable new ideas no one can imagine.

The following pages provide an overview of several core services proposed by Sidewalk Labs, as well as a description of the urban data they use, an illustrative sense of what their RDU Assessments could emphasize, and the types of third-party innovations that they might make possible.

Merely collecting urban data is not an end to itself. Urban data should only be gathered as a means of creating a new application, use, service, or product that can improve the lives of city residents, workers, visitors, and businesses.

Sidewalk Labs' role in digital services. As explained on Page 382, Sidewalk Labs plans to offer this limited set of core digital services in cases where achieving fundamental project goals around transportation, affordability, housing, energy, public space, and other areas would require an innovation the market has not pursued.

Some of these launch services could still involve working with partners or buying existing technology, and other entities would be free to develop competing services. All proposed digital services would be subject to the proposed responsible data use approval process overseen by the Urban Data Trust, which would include completing RDU Assessments to ensure privacy is protected.

Digital pilot

GRIT Toronto: Involving the community in digital tool development

Traditionally, user testing has taken the form of market research: a small group of people is recruited to come to an office during working hours to give feedback on a new technology. This method can result in narrow or even biased feedback.

To explore a more inclusive kind of user testing, Sidewalk Labs is currently funding GRIT Toronto (Gathering Residents to Improve Technology), a program founded by Code for Canada. The program meets people of all digital skill levels, cultures, ages, and backgrounds where they are — in community spaces outside of working hours, for example — and incorporates their feedback into the creation of new digital services and products, helping to ensure these tools reflect the needs of the populations they are intended to support.

Launched in late 2018, the GRIT Toronto pilot has recruited over 350 residents from Toronto's 25 wards, representing a diversity of backgrounds, lived experiences and technical skill levels. What unites them is a desire to shape the digital products and services that could impact their lives and their city. This initiative could help software developers in Quayside collaborate with a broad range of community members and ensure that their digital solutions truly have neighbourhood needs in mind.

Sidewalk Labs' proposed launch services

This table seeks to provide an overview of the initial digital services proposed by Sidewalk Labs as part of the Sidewalk Toronto project, including a sense of their purpose, data sources and access, and potential to catalyze third-party innovation. All digital innovations (whether created by Sidewalk Labs or others) would be subject to the independent responsible data use approval process described on Page 424, as well as applicable privacy laws. The information here should be viewed as illustrative but not necessarily exhaustive.

Sidewalk Labs' proposed service or application	What urban data it proposes to use and/or publish	Possible third-party applications that could build on this data	What existing ecosystem the innovation supports (Names are illustrative only.)
Mobility management system To reduce congestion and encourage shared trips, this proposed mobility management system would coordinate all travel modes, traffic signals, and street infrastructure, and apply demand-based pricing to curb and parking spaces.	**Non-personal:** Curb space availability (e.g., occupancy sensors) **Non-personal and/or de-identified at the source:** Pedestrian and cyclist detection and counts; vehicle detection, counts, speed **Restricted data (not published for privacy reasons):** Vehicle identification data, such as license plates or transponders, collected and used directly by the city for parking enforcement	A **policymaker** could create more informed policy decisions around parking availability and transit service. A **self-driving technology** startup could improve its pedestrian-detection system. A **researcher** could detect pedestrian near misses and evaluate the performance of intersection designs on street safety. **Employers** could start programs that encourage workers to shift commute times to decrease congestion.	**Self-driving vehicles:** Aptiv, Cruz, Lyft, Uber, Waymo **Sensor and traffic management:** Axilion, Brisk Synergies, GRIDSMART, LeddarTech, Miovision, NoTraffic, Numina, P3Mobility, RapidFlow, SMATS Traffic Solutions **Parking:** Cloudpark, Curbway, Jrop, Passport, Pay by Phone, Sensys **Routing apps:** Apple/Bing/Google Maps, Transit App, Waze
Outdoor comfort system A proposed system of outdoor-comfort tools, deployed in real time, could dramatically increase the amount of time it is comfortable outside, including building "raincoats" to block rain, awnings to provide shade, and fanshells to provide group cover.	**Aggregated and/or non-personal:** Hyper-local temperature, humidity, wind speed, rainfall, and sunshine levels **Non-personal:** Raincoats and fanshell status	A **retail startup** could build an app that identifies the best locations or times for a pop-up store based on weather patterns. **Health organizations** could build apps that show residents a jogging route that avoids wind and snow and maximizes sun and interesting views. (These apps could also draw from the mobility sensors to avoid congested areas.)	**Weather data:** Ambience Data, Earth Networks, IBM, The Climate Corporation **People flow:** Ecocounter, Numina, PeopleFlow
Flexible retail platform (Seed Space) A proposed leasing platform called Seed Space would help small businesses and other retailers book a wide range of ground-floor space sizes, from anchor-tenant spaces to micro stalls, for short- or long-term uses.	**Aggregated and/or de-identified:** Footfall and rate data, aggregated tenant turnover rates **Non-personal:** Space size, availability **Restricted data (not published for privacy reasons):** Leasing, rent, or transactional data collected with clear consent	A **retail startup** could create an app that determines the best times of the year or day for an entrepreneur to set up in the area. (This use could also draw on hyperlocal weather data from the outdoor comfort system.) An **economic development firm** could conduct (or have a startup create an app to conduct) retail industry analyses of neighbourhood turnover rates by size of space. **Business Improvement Areas** could use this data to understand the economic impact of events or policy decisions.	**Location mapping:** InnerSpace, MappedIn **Space mapping:** A Retail Space, Chatter Research, POTLOC **Space availability:** Booqd, Breather, Harbr, PiinPoint
Open space usage and management (CommonSpace) A proposed digital application called CommonSpace (created with the local organization Park People and the Gehl Institute) would make it substantially easier, faster, and less expensive to collect more reliable data on how people use public spaces — helping park operators better respond to community needs.	**Aggregated and/or non-personal:** Gehl public realm activity categories, usage counts **Non-personal:** Extremely high-level demographic details	**City planners, community groups, and others** could use this information to research park spaces and equipment that show the highest use in different parks throughout the city. **Community-based groups** could develop planning apps and tools that allow community members to better suggest park uses for all ages and abilities in their neighbourhoods.	**Open space management:** Range of government, non-profit, and community groups **Park operations:** Gehl Institute and other urban planning and design groups **City operations:** mySidewalk, Namara, Stae, and other platforms supporting city operations insights
Public realm maintenance map A proposed real-time map of public realm assets — from park benches to drinking fountains to landscaped gardens — would enable proactive maintenance and keep spaces in good condition.	**Non-personal and/or aggregated:** Evapotranspiration, plant health, moisture, waste bin volume, air quality **Non-personal and/or de-identified:** Public realm asset location, usage, damage detection; decibel meter (e.g. only volume level, not recording audio)	**Software developers** could use this information to create automated maintenance services, such as precision agriculture systems or landscaping bots. **Industrial manufacturers** could use data on utility maintenance to identify more durable materials or component designs. **City officials, business improvement districts, and others** could use this information to better schedule core operations, such as waste collection or green-space watering, to lower costs and improve quality of life.	**Physical asset location:** Bench Mark, BeWhere Inc., Estimote, Tekt **People flow:** Eco-Counter, Numina, PeopleFlow **Autonomous equipment:** BigMow, Husqvarna, Kobi **Predictive maintenance:** AI Incorporated, Arable, Mero Technologies, Nanophyll, Opti, Plantix, Sensoterra

Sidewalk Labs' proposed service or application	What urban data it proposes to use and/or publish	Possible third-party applications that could build on this data	What existing ecosystem the innovation supports (Names are illustrative only.)
Civic engagement (Collab) A proposed digital application called Collab (prototyped with local communities and Digital Public Square, a non-profit spun-out of the University of Toronto) would aim to engage community members in local decisions that could shape their neighbourhood, such as programming in a central public space, through a transparent process that reveals the decision-making framework and all community inputs. (Try the prototype at collab.sidewalklabs.com.)	**Non-personal:** Program choice selections, pre-populated and user-generated options **Aggregated and/or de-identified:** Broad demographic information (only upon clear opt-in / consent)	A **neighbourhood association** could clearly explain the tradeoffs associated with a decision about public space programming: for example, a farmers market provides fresh produce and draws a lot of foot traffic, but the space may feel too congested for a community picnic. A **research team** could analyze data to see if inputs are inclusive and representative of the community. A **community group** could evaluate user-generated inputs without revealing personal information.	**Public input support:** Range of government, non-profit and community groups such as neighbourhood associations, business improvement areas, public realm management organizations, and planning departments **Community engagement and decision making:** Decidem, Neighborland, Ethelo, and other platforms
Outcome-based building code This proposed real-time building code system could monitor noise, nuisances, and structural integrity to help a mix of uses thrive without sacrificing public safety or comfort.	**Non-personal, aggregated, and/or de-identified:** Strain gauges, vibration, odour, sound pressure, decibel meter (e.g. only volume level, not recording audio) **Aggregated and/or non-personal:** Safety sensors (e.g. sprinkler pipe pressure, fire pump diagnostics, heat, smoke, CO2, CO PM 2.5, PM10, VOC, lead detection) **Restricted data (not published for privacy reasons):** Individual measurement data for the safety metrics above	**City government** could use this information to develop new outcome-based regulatory systems for code compliance. **Planning researchers** could use this information to study the relationship between mixed-use development and local economic growth. **City agencies or architectural groups** could create apps to visualize building structural integrity issues.	**Environmental collection:** Aclima, AQMesh, Awair, Concrete Sensor, Fibos, Koto Labs, NoiseAware, Safehub **Building outcomes mapping:** The Black Arcs, Map Your Property, RATIO.CITY
Active stormwater management A proposed active stormwater system would rely on green infrastructure and digital sensors to retain stormwater, reuse it for irrigation, and empty storage containers in advance of a storm to avoid combined sewer overflow.	**Non-personal and/or aggregated:** Stormwater tank level, stormwater flow meter, total suspended solids, valve and gate status, underwater water quality near shore	**Environmental researchers** could design an app to determine the number of plantings and amount of greenery needed to reduce stormwater flows and the need for secondary treatment. **City planners** could use this information to better plan (and minimize) hard infrastructure needs for stormwater, such as tanks and treatment facilities.	**Digital management:** Aquatic Informatics, IBM, Innovyze, Opti, Parjana, RainGrid, SUEZ, Veolia North America **Water quality:** Acoubit, FREDsense, Orb, Xylem, ZwitterCo

Sidewalk Labs' proposed service or application	What urban data it proposes to use and/or publish	Possible third-party applications that could build on this data	What existing ecosystem the innovation supports (Names are illustrative only.)
Energy management system (Schedulers) This proposed system of Home, Office, and Building Operator Schedulers would automate energy use to optimize residential, commercial, and building heating, cooling, and electricity systems — reducing energy waste and relying on clean energy while increasing tenant comfort.	**Non-personal:** Outdoor weather **Aggregate and/or de-identified:** Data on room temperature and humidity; energy use by type (e.g., from plug loads, lighting, HVAC); motion or occupancy; ambient light; comfort levels / complaints **Restricted data (not published for privacy reasons):** Individual measurement data for the metrics above (e.g. timestamped data about particular plug loads, occupancy detection for particular rooms) and any data about individual residential units	**Energy researchers** could use this data to compare neighbourhood energy usage across a city. **Architects and designers** could use this information to improve building designs. **Regulators** could use this information to create a dynamic energy code system based on actual operators instead of design-based models. **Climate organizations** could create apps to help individuals or households gamify their energy savings (provided users consent to share their data).	**Building management systems:** Automated Logic Controls, Johnson Controls, Schneider, Siemens **Niche building analytics providers:** Basking Automation, Comfy, eleven-x, Encycle, Parity, Peak Power, Cortex, Raybased, SensorSuite, SimpTek, SHIFT Energy, Thoughtwire, Density, InnerSpace **Energy use measurement:** VoltServer, Enertiv, Sense, Wemo, Currant **Thermostats:** Ecobee, Honeywell, Google Nest, Samsung **Smart switches, lighting, appliances, and other hardware:** Lutron, Enlighted, LG, TZOA
Building waste management systems To help divert landfill waste, a proposed program of responsive digital signage would help residents and businesses sort their trash, recyclables, and organics (foods) by illustrating common sorting mistakes. "Pay-as-you-throw" waste chutes would support this recycling program while helping to reduce overall waste.	**Aggregated and/or de-identified:** Trash volume, pressure scales (weight), waste classification for sorting using computer vision, contamination issues	An **environmental researcher** could team up with a fabrication studio to design a more sustainable coffee-cup lid based on disposal habits. **City planners** could use this information to understand best practices in buildings and to test new systems and strategies to scale to other buildings. **Computer-vision startups** could use information on common recycling errors to design augmented-reality apps that could help people classify waste. **Environmental groups** could design an app that provides feedback to consumers, both residential and commercial, encouraging higher recycling rates.	**Smart waste:** AMP Robotics, Anaconda, CleanRobotics, Compology, Enevo, Recycle Track Systems, Rubicon Global, Zerocycle

Spotlight 1

Launching Core Digital Services
That Others Can Build On

An outcome-based building code system to enable a safe, vibrant mix of uses

For most of the 20th century, cities separated residential, commercial, and industrial uses geographically to protect homes from noise, air pollution, and other nuisances.[44] This approach made sense in a world without reliable tools to monitor the environmental nuisances of commerce and industry. But it also discouraged an active mix of home, work, and retail into the same neighbourhood — let alone the same building.

Working alongside local government, Sidewalk Labs proposes to create a real-time building code system designed around the premise that buildings should be able to house a diverse range of tenants — residential, commercial, and light industrial alike — so long as everyone adheres to agreed-upon "outcomes," such as minimizing noise, air pollution, and other public nuisances.

What urban data it proposes to use.

The proposed outcome-based building code system would monitor several types of building regulations on an ongoing, real-time basis via environmental sensors that collect non-personal data. The environmental information collected is considered "urban data," because it would be data collected in a privately owned common space in the IDEA District.

Devices would be placed in building hallways to collect information on structural integrity and vibration, odours, interior air quality, and noise levels. This system would be designed to collect only the specific data pertaining to building codes. Additionally, buildings would implement non-personal safety sensors to measure things like sprinkler pipe pressure, fire pump diagnostics, heat and smoke, and particulate matter.

This information would be provided from the third-party owners of these devices to an outcome-based code datastore. Any violation detected in this datastore would be sent to building managers for next steps and resolution.

In the case of an emergency (e.g., fire) or non-compliance, municipal officials could query the database directly.

What the RDU Assessment could consider.

The beneficial purpose of this proposed innovation would be to enable a greater mix of residential, commercial, and light industrial spaces, helping to create a lively local economy and achieve Waterfront Toronto's goals for complete communities. The collection of urban data would be necessary to ensure the industrial spaces would comply with regulatory conditions, such as noise and odour requirements, thus enabling both commercial and residential tenants to coexist safely.

The proposal would be developed in accordance with the RDU Guidelines. The expected impact on people would be small, given that the sensors involved in this initiative would collect non-personal information related to building codes. Because this data could be linked to individual building hallways, however, this data would be considered restricted and not publicly accessible. For these reasons, Sidewalk Labs believes the balance of impact of collecting the environmental data would weigh in favour of the proposal.

See the "Buildings and Housing" chapter of Volume 2, on Page 202, for more on outcome-based building codes.

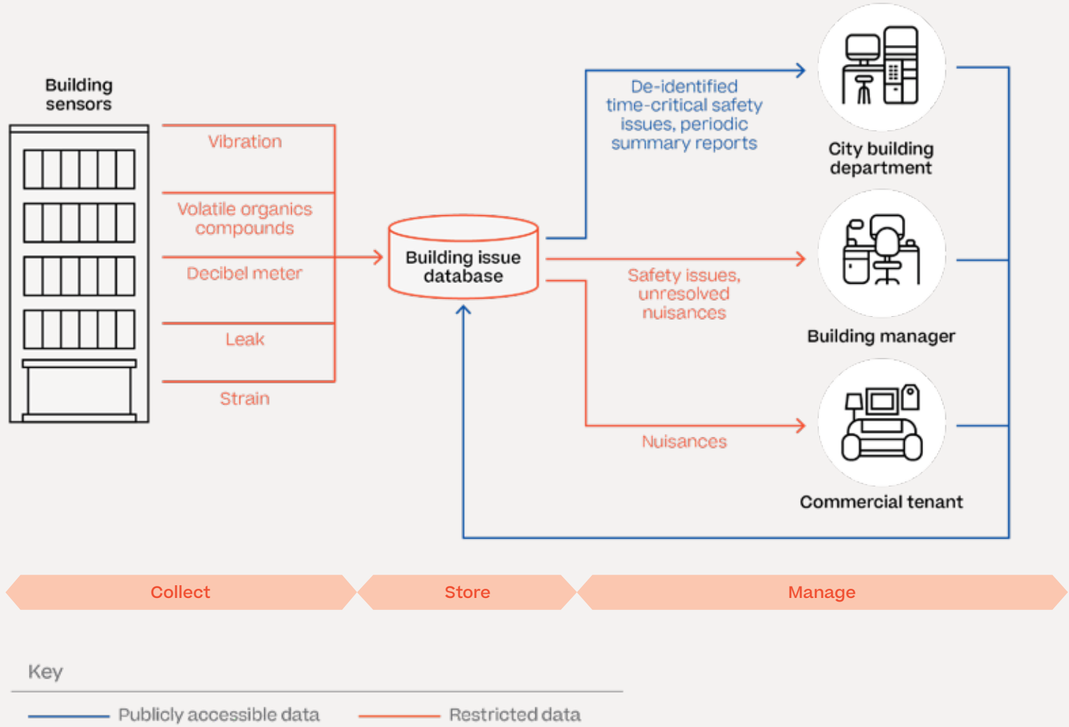
What it makes possible by others.

The non-personal data collected by the outcome-based code system, as well as information aggregated by neighbourhood level, would be shared with a publicly accessible API, enabling third parties to build on top of it.

A potential future innovation could include the adoption by city government of a new system for code compliance or zoning based not on pre-existing, rigid standards but rather on real-time performance to help Toronto achieve its goals for mixed-use development. Additionally, city agencies or their private vendors might create an app to visualize a building's structural-integrity issues in real time. Such a tool could save money by efficiently identifying problems and catalyzing proactive maintenance.

How it works: Outcome-based code

Building sensors that detect code violations could send these issues to a restricted database accessible by the city, building managers, and tenants, with only aggregated data publicly accessible to third parties.



Spotlight 2

Launching Core Digital Services
That Others Can Build On

An Office Scheduler to optimize energy use

Today, no one is focused on saving energy in commercial tenant spaces, such as offices. Existing energy management programs that could optimize thermostats and ventilation systems in commercial spaces are under the control of the building operator, not the tenant.[45] The result is that offices often operate based on default system schedules that do not match the tenant's needs.

To help commercial tenants manage energy consumption and costs, Sidewalk Labs proposes to use a tool called the Office Scheduler that would optimize all the systems under tenant control, based on factors such as energy prices. This tool is part of a suite of Scheduler tools that together would reduce greenhouse gases compared with standard downtown buildings, consistent with Waterfront Toronto's ambitions for achieving a climate-positive community.

What urban data it proposes to use.

To achieve this goal, the Office Scheduler would need visibility into electricity usage and cost, as well as real-time metering of all building energy systems, such as heating, cooling, lighting, and equipment. An encrypted building-energy datastore would aggregate information and automatically determine any optimization steps across systems for both occupant comfort and energy savings.

The proposed Office Schedulers would incorporate data from a set of energy management sensors (such as ambient lights, motion sensors, plug load monitors, room temperature gauges, and digital thermostats) as well as from computer systems (such as calendar notifications) to reduce energy use when rooms are unoccupied or already comfortable. This information would be provided from the third-party owners of these devices to a data format translator.

To register requests for temperature changes from workers, the Office Scheduler would use some personal information by direct consent through an app (making this transaction data). This information could be used to respond to worker complaints, and if a change could not be accommodated due to competing requests, it could be used to guide workers to areas of the office that might be more comfortable.

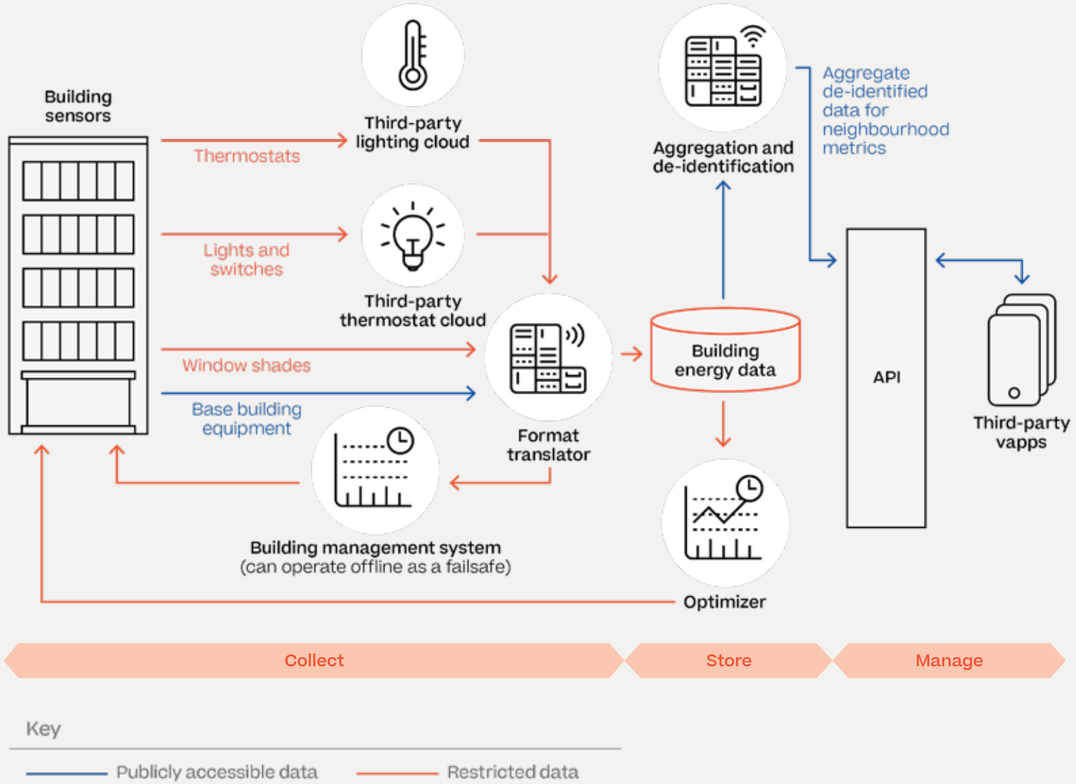
What the RDU Assessment could consider.

The beneficial purpose of the Office Scheduler is to help achieve a climate-positive community through reducing energy consumption in commercial spaces and to optimize for clean energy use. Other benefits include a 20 percent reduction in building energy operating costs (when used in concert with the other Scheduler tools) and greater comfort for workers.

The expected negative impact on people would be small, given that minimal personal information is required and would be de-identified or aggregated for its

How it works: Office Schedulers

Information from energy-related sensors would help the Office Scheduler tool optimize building energy use, with aggregated and de-identified data made publicly accessible to third parties.



See the "Sustainability" chapter of Volume 2, on Page 296, for more on the proposed Office Scheduler.

intended use. Non-personal and de-identified data, including neighbourhood-level metrics, would be made publicly accessible so that others could use this data. Personal information (which is subject to Canadian privacy laws) would be stored in a secure database with access restricted to certain employees and agents and only be kept as long as necessary to fulfill the original purpose.

While the Office Scheduler proposes to automate some energy actions, tenants would have the ability to override the automated system, and the algorithm would also undergo a Responsible AI assessment. Sidewalk Labs believes the balancing of the risks of collecting the data in offices would weigh in favour of the data collection activity.

What it makes possible by others.

Third-party apps and services would be able to use de-identified and aggregated data for research purposes, such as comparing neighbourhood energy usage across a city to improve building designs or evaluate energy policies, or to create new tools, such as behavioural apps that help families gamify their energy savings.

Spotlight 3

Launching Core Digital Services
That Others Can Build On

A mobility management system to reduce congestion and improve safety

Sidewalk Labs' proposed mobility management system would use non-personal and de-identified urban data (such as trip counts, traffic congestion measures, and curbside availability information) to help manage the transportation network in line with objectives around street safety, shared trips, and travel times. This tool would be able to understand how people are using the entire system (including all trip modes), analyze these travel patterns, and encourage trip choices that do not rely on private cars — all in real time.

What urban data it proposes to use.

To estimate traffic flows or prioritize pedestrian safety, lidar, radar, and cameras would need to be able to detect all travellers and vehicles at an intersection, de-identifying that information on the device and providing only an aggregate count. To manage congestion around curb spaces, in-pavement occupancy sensors would need to detect the presence of vehicles without identifying specific vehicles. A separate licence plate reader could capture parking data about vehicles violating parking rules to send it directly to the city for municipal enforcement.

Municipal enforcement could be performed via traditional methods used by the City of Toronto today, or improved by providing enforcement agencies with better information and tools (such as recommended areas where violations are more likely) or systems that enable the city to perform automated enforcement (such as vehicle transponders or license-plate readers).

The data collected by the mobility system could flow to two key databases. All non-personal and de-identified information could flow to an open datastore, publicly accessible via an API. Private data could flow to an enforcement datastore, with access restricted to municipal officials only.

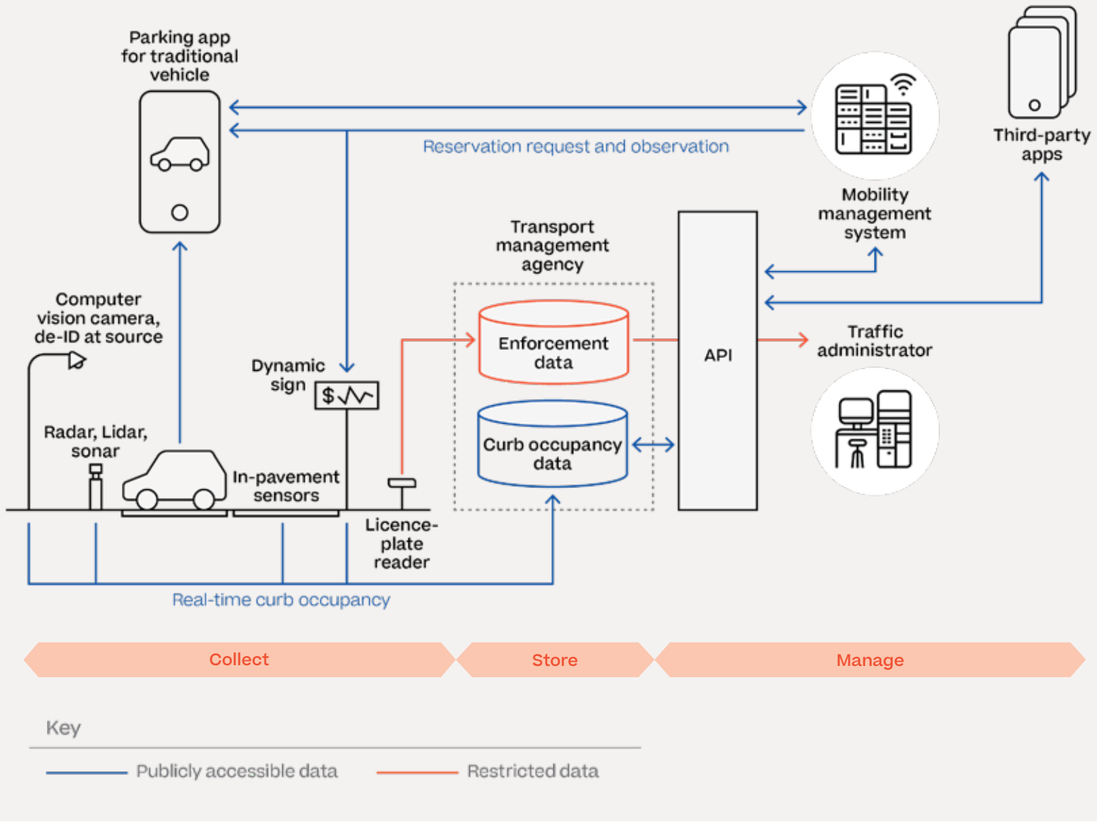
What the RDU Assessment could consider.

This mobility management system formed the basis for the illustrative RDU Assessment case study on Page 436. As noted there, Sidewalk Labs believes that under the proposed RDU Guidelines, this proposal would gain approval for having a beneficial purpose related to travel time and increased public transit use, helping to achieve Waterfront Toronto's objective for sustainable transportation. Privacy risks would be mitigated through de-identification.

If necessary, some of this data could be collected by a public entity that is authorized to enforce relevant bylaws and regulations. In these cases, only the city would have access to this data. As such, this collection and use would be governed by the Municipal Freedom of Information and Protection of Privacy Act, and the city would follow its own privacy practices.

How it works: Mobility Management System

To operate a "dynamic curb," a mobility management system collects information about curb availability, stores that information in databases, and makes non-restricted data publicly accessible to third parties.



See the "Mobility" chapter of Volume 2, on Page 22, for more details on the proposed mobility management system.

What it makes possible by others.

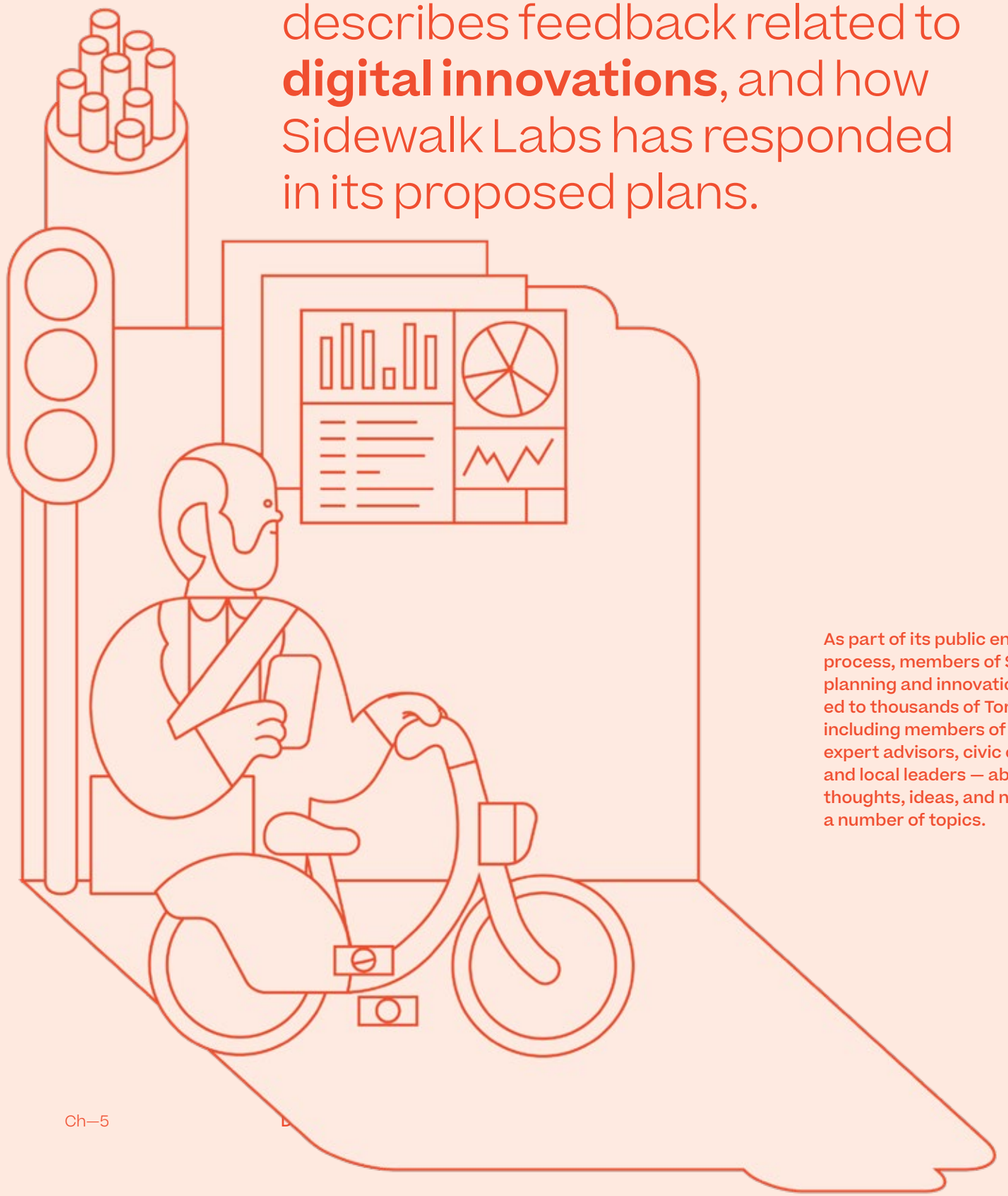
This mobility management system — along with third-party developers who create navigation apps or ride services — would be able to pull publicly accessible data from the API to provide travellers with information that helps them make trip choices, such as public transit arrival times, bike-share availability, or prices for curb space. Such publicly accessible data would also enable third parties to create new services in the future.

For example, a navigation app might use the aggregate trip patterns and available mode options to provide users with the fastest, cheapest, or greenest routes from A to B. Self-driving vehicle companies could use the information on intersection movement to improve technology that detects pedestrians or cyclists. Local officials would be able to use the curbside availability data to propose new guidelines for ride-hail services.

Ch–5

Public Engagement

The following summary describes feedback related to **digital innovations**, and how Sidewalk Labs has responded in its proposed plans.



As part of its public engagement process, members of Sidewalk Labs' planning and innovation teams talked to thousands of Torontonians — including members of the public, expert advisors, civic organizations, and local leaders — about their thoughts, ideas, and needs across a number of topics.

1 Protect people's privacy and use data to serve the public good

What we heard

Throughout the public engagement process, Torontonians were loud and clear: data privacy matters. Residents were wary about third-party access to data collection and the commercial sale of data. The Data Governance Advisory Working Group recommended that "Privacy by Design" principles be incorporated into the project. The Sidewalk Toronto Fellows advised Sidewalk Labs to ensure that, as a first principle, data be collected and used with the public good in mind.

Public Roundtable 4 participants who took part in a data-focused discussion were particularly helpful in defining the use cases they were comfortable with. For example, as long as data was de-identified, residents felt comfortable with data being collected and used for transit and mobility purposes. As one Reference Panel resident said: "Cities need aggregate data. … They need to know which modes of transportation people take when it's raining. They need to know how many people went through an intersection, not who went through it. And if they can legitimately anonymize the data they collect then I would accept that."

The Residents Reference Panel had many data-related concerns, including the need to ensure that algorithms would not perpetuate existing biases. They also wanted to ensure the cyber-security of this tech-enabled neighbourhood would be state of the art.

How we responded

Designing for privacy.
For all its projects, Sidewalk Labs plans to incorporate Privacy by Design, an approach that requires thinking about potential privacy impacts at the very start of a project lifecycle and proactively embedding privacy measures into the design of a project (see Page 424).

Creating a steward.
To protect personal privacy and the public good, Sidewalk Labs proposes the creation of an independent entity called the Urban Data Trust to oversee digital matters and approve (or deny) proposals to collect or use urban data in the IDEA District (see Page 420).

Establishing guidelines.
Sidewalk Labs proposes that the Urban Data Trust establish a set of RDU Guidelines that apply to all parties engaged in the collection and use of urban data in the IDEA District. These guidelines would build on the strong existing framework of Canadian privacy laws (see Page 424).

Increasing transparency.
Sidewalk Labs proposes that all entities complete RDU Assessments with any proposal to collect or use urban data to ensure that digital services abide by the RDU Guidelines. RDU Assessments would be filed and publicly registered with the Urban Data Trust before a project or service could launch (see Page 429).

Benefiting people.
Sidewalk Labs commits to applying Canadian values of diversity, inclusion, and privacy as a fundamental human right to its digital projects, providing a clear purpose and benefit to any proposed collection and use of urban data. No data for data's sake (see Page 424).

De-identifying by default.
Sidewalk Labs proposes that one of the RDU Guidelines state that personal information must be de-identified by default at first use, so it cannot be traced back to any individual (see Page 424).

Enhancing security.
Sidewalk Labs proposes to deploy a new security approach called "software-defined networks" capable of detecting security compromises and isolating impacted devices from the network (see Page 392). Sidewalk Labs also proposes to base all security and reliability standards on best practices and to emphasize resiliency across its systems (see Page 408).

Being proactive.
To establish a proactive approach to security, each digital system Sidewalk Labs proposes would use a preparedness assessment to provide clear answers to key questions on threat modelling and response readiness (see Page 412).

Protecting from ads.
Sidewalk Labs commits that it would not sell personal information to third parties or use it for advertising purposes. To encourage such behaviour from other companies or entities operating in the IDEA District, Sidewalk Labs proposes that the Urban Data Trust place greater levels of scrutiny on projects wishing to use personal information for ad purposes, including the need to justify this decision and to obtain explicit consent from users (see Page 425).

2 Earn public support through transparent policy, clear language, and data education

What we heard

Participants were concerned that Torontonians needed more education to advance their data literacy and that companies and organizations needed to be more transparent in the ways they collect data. They wanted to know more about how data collection would happen in a place like Quayside.

The Sidewalk Toronto Fellows, Reference Panel residents, and Roundtable participants urged Sidewalk Labs to proactively disclose when (and what kind of) data is being collected and used in clear language. As one roundtable participant noted: "Data privacy and responsible data use needs genuine commitment — that includes being specific and transparent about how it will be used."

Participants also wanted to ensure ways to consent or opt-out of data collection and use, especially in public spaces, where meaningful consent is a challenge. The Data Governance Advisory Working Group suggested that signage alerting the public to what data is being collected and how it is being used could be helpful.

How we responded

Being transparent.
Sidewalk Labs proposes that all projects aiming to collect or use urban data must inform individuals of how and why their information is being collected and used, and do so in a way that is proactive, clear, and easy to understand — not written in legalese (see Page 424).

Providing clarity.
For the collection of urban data in public spaces, where meaningful consent cannot reasonably or reliably be achieved, Sidewalk Labs proposes that entities provide clarity of usage through efforts such as physical signs notifying people of a data device or informational websites describing a service or program in greater detail (see Page 424).

Improving design.
Sidewalk Labs released via Github a draft of new design patterns co-created with more than 100 participants from several cities worldwide. The goal of the new patterns was to build on the consent and notice requirements that exist under current privacy laws in a way that increases digital transparency and helps people quickly get a sense of the privacy implications associated with responsible urban data collection.

Registering devices.
Sidewalk Labs proposes that the Urban Data Trust not only approve the placement of data-collection devices but also publish and maintain an online registry and map of device locations, with easily accessible information on what kind of data is being collected, why, how, where, and by whom (see Page 433).

Supporting literacy.
In Quayside, Sidewalk Labs proposes to establish a Tech Bar that would provide community members with small-group or one-on-one assistance with digital tools, with the goal of improving digital literacy among the local community.

Attendees of the "Digital Transparency in the Public Realm" workshop are hard at work. Credit: Sidewalk Labs

3 Tech should be an enabler and an accessible amenity

What we heard

Residents were excited about the opportunity for Quayside to be a world leader in urban technology and to encourage and enable future tech innovations.

Torontonians hoped the Sidewalk Toronto project would improve existing public services, potentially by leveraging technology. As one Reference Panel resident explained: “The challenge is to find ways for technology to help foster a sense of community. That seems utopian but it’s possible… I think Toronto can be a global model for a new kind of technology that helps keep us human.” Participants were also open to new tools or options that would give community members more of a voice in decisions on programming and services.

Other residents were excited by new potential services, such as enhanced Wi-Fi connectivity. Still others wanted to see technology that would make Quayside more accessible, such as customizable tech that could be experienced in multiple ways.

The Data Governance Advisory Working Group encouraged Sidewalk Labs to pursue open data whenever possible, and the Sidewalk Toronto Fellows recommended that Sidewalk Labs develop an open data portal to encourage innovation for the public good.

How we responded

Connecting people.
Sidewalk Labs proposes to create a super-fast, ubiquitous connectivity network that would provide residents, workers, and businesses access to their own secure, personal high-speed network — no matter where they are — at an affordable cost (see Page 384). For people without smartphones or computers, devices and Wi-Fi kiosks would be available and free to use in communal spaces.

Standardizing data.
Sidewalk Labs plans to publish data in standard formats and via well-defined, public APIs. Where standards do not exist, Sidewalk Labs plans to work with companies, researchers, and standards bodies to create those standards (see Page 405).

Opening data.
To encourage innovation, Sidewalk Labs plans to make publicly accessible all urban data that could reasonably be considered a public asset. Sidewalk Labs plans to work with organizations and companies that are already building open data portals to provide access to this data, and also proposes that the Urban Data Trust facilitate integration with existing open data portals and tools (see Page 406).

Opening code.
Sidewalk Labs plans to make software source code public under free software licences and to encourage other entities creating services in the IDEA District to do the same (see Page 406).

Avoiding lock-in.
Sidewalk Labs proposes that any digital infrastructure it deploys be open to competition and alternatives. As one example, it proposes to deploy a new type of standardized mount that would make it easier for cities to swap in new digital tools and avoid relying on proprietary services (see Page 380).

Prioritizing accessibility.
In keeping with its accessibility principles, Sidewalk Labs commits to offering technology in multiple modes and maintaining best accessibility practices. (For further reading on accessibility, see Volume 1.)

Supporting inclusive usability testing.
Sidewalk Labs is currently funding GRIT Toronto, a program founded by Code for Canada that incorporates community feedback into the creation of new digital services and products, helping to ensure these tools reflect the needs of the populations they are intended to support (see Page 443).

Enabling civic engagement.
Sidewalk Labs is developing a prototype with Digital Public Square called Collab that would allow community members to propose ideas for events in their neighbourhood. The tool is designed to walk users through the tradeoffs associated with various proposals, including how their individual choice would impact the community (see Page 446).

Sidewalk Labs’ Director of Design Michelle Ha Tucker describes the co-design process during a “Digital Transparency in the Public Realm” workshop at 307. Credit: Sidewalk Labs

4 Establish an ethical data governance model for the long-term

What we heard

The Sidewalk Toronto Fellows recommended that Sidewalk Labs establish an independent entity to ensure data stewardship, and the Residents Reference Panel suggested that, when possible, data be stored, regulated, and analyzed in Canada.

Residents wanted to know more about the Civic Data Trust initially proposed by Sidewalk Labs in 2018, including how the trust would integrate into existing legal and regulatory frameworks and ensure compliance for all. (The entity has now become the Urban Data Trust; see Page 423 for details on this shift.)

Residents also wanted to better understand the data-governance model overall — including how long-term data management and storage would work — and how the government could provide appropriate oversight over the project.

How we responded

Implementing an entity.
As noted earlier, Sidewalk Labs proposes the creation of an independent entity called the Urban Data Trust with the capacity to approve all proposals for use and collection of urban data and with a mandate to balance the public interest and the need for innovation (see Page 420).

Building on laws.
Sidewalk Labs proposes that the Urban Data Trust coordinate with privacy regulators and that the responsible data use process build on (not replace) existing privacy laws (see Page 419).

Ensuring accountability.
Sidewalk Labs proposes that the Urban Data Trust uphold data agreements through contracts that are legally enforceable and actionable (see Page 421).

Thinking long-term.
Looking long-term, Sidewalk Labs puts forth that the Urban Data Trust could be ultimately transformed into a public-sector agency or a quasi-public agency, either of which could give it more long-term viability or broader coverage (see Page 422).

Localizing data.
Sidewalk Labs commits to using its best efforts at data localization, as long as there are Canadian-based providers who offer appropriate levels of security, redundancy, and reliability. To the extent that it is deemed infeasible to store data solely in Canada, Sidewalk Labs would be transparent about such a decision (see Page 412).

Engagement spotlight

Attendees talk during the first "Digital Transparency in the Public Realm" workshop in Toronto. Credit: Sidewalk Labs

Alyssa Harvey Dawson heads privacy and data governance for Sidewalk Labs. When she first started at the company, she knew that the challenges facing a company whose mission is radically improving urban life through the use of technology would be unique. This realization came into greater focus in conversations with the Data Governance Advisory Working Group.

The working group pushed Alyssa and her team to consider how data privacy, use, and management take on new meanings when the source of that data is the public realm. "You can't just focus on personal information, which is where most privacy laws begin and end," says Alyssa. "The scope of data that could be collected from a private actor in public spaces, where you don't have all the usual protections, makes the concerns much more heightened. You have to think more broadly about the impact on people."

In response, Alyssa and her team coined a term, "urban data," that refers to aggregate, non-personal, de-identified, or personal data gathered in the physical spaces of a city, including its public realm, its publicly accessible spaces, and even some private spaces. They then proposed the creation of an independent entity that would represent the public interest and serve as the steward for the collection and use of all urban data across the IDEA District.

With these proposed initiatives, Alyssa and her team hope to advance the conversation about responsible data use in cities in new directions and inspire local solutions to this critical — and growing — challenge.

Toronto can demonstrate to the world that cities do not need to sacrifice their values of inclusion and privacy for economic opportunity in the digital age.

Acknowledgements

Sidewalk Labs would like to extend special thanks to the participants of the Sidewalk Toronto Data Governance Working Group, and to the staffs of the City of Toronto, Province of Ontario, and Government of Canada for their time and guidance.

Endnotes

General note: Unless otherwise noted, all calculations that refer to the full proposed IDEA District scale are inclusive of the entirety of its proposed geography, including all currently privately held parcels (such as Keating West). Unless otherwise noted, all currency figures are in Canadian dollars.

Charts note: Sources for the charts and figures in this chapter can be found in the accompanying copy for a given section; otherwise, the numbers reflect a Sidewalk Labs internal analysis. Additional information can be found in the MIDP Technical Appendix documents, available at www.sidewalktoronto.ca/midp-appendix.

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